Evaluation of Level(s)

Lessons learned from 18 Danish examples

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Harpa Birgisdottir
Kim Haugbølle

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Danish Building Research Institute, Aalborg University Copenhagen
2019

TITLE	Evaluation of Level(s)
SUBTITLE	Lessons learned from 18 Danish examples
SERIAL TITLE	SBi 2019:11
EDITION	1. edition
YEAR	2019
DIGITAL PUBLICATION DATE	December 2019
AUTHOR	Harpa Birgisdottir & Kim Haugbølle
LANGUAGE	English
PAGES	157
REFERENCES	Page 148
KEYWORDS	Sustainable buildings, life cycle, LCA, LCC, certification
ISBN	978-87-563-1932-4
COVER	Graves K. Simonsen
PUBLISHER	Statens Byggeforskningsinstitut (SBi), Aalborg Universitet Danish Building Research Institute, Aalborg University A.C. Meyers Vænge 15, 2450 Copenhagen SV E-mail sbi@sbi.aau.dk www.sbi.dk

CONTENTS

PREFACE

This report covers the evaluation of the Danish test of the proposal for a new joint European reporting scheme for sustainable construction named Level(s). The Danish evaluation included a total of 18 building and renovation projects involving a large number of Danish companies.

For readers only interested in the overall lessons learned, it is recommended to read the extended “Executive summary” or the Danish version “Dansk sammenfatning”. Readers interested in the detailed analysis are encouraged to study the entire report with its approximately 150 pages and around 200 tables.

The project titled ”Danish test and contribution to the development of Level(s) for Sustainable Buildings” was funded by the two private foundations Realdania and Grundejernes Investeringsfond (GI – The Landowners’ Investment Foundation) along with in-kind contributions from the participating companies.

The project manager was Peter Andreas Sattrup from Danske ARK (The Danish Association of Architectural Firms). The other participants in the evaluation were FRI (the Danish Association of Consulting Engineers), DI Byg (The Confederation of Danish Industry), Bygherreforeningen (The Danish Association of Construction Clients), and DK-GBC (Green Building Council Denmark).

Declaration of financial interests: This evaluation report was written by the Danish Building Research Institute on request from TBST (Danish Transportation, Building and Housing Agency). Additional funding was provided from the private foundation Grundejernes Investeringsfond (The Landowners’ Investment Foundation).

Danish Building Research Institute, Aalborg University
Department of Energy Performance, Indoor Environment, and Sustainability of Buildings

Søren Aggerholm
Research Director

EXECUTIVE SUMMARY

About Level(s)

The European Commission (EC) has launched Level(s), which is a common European framework for measuring and reporting sustainability for new construction and major renovations of residential buildings and offices. Level(s) consists of a set of core indicators and common metrics for measuring the sustainability of buildings over their life cycle. The purpose of Level(s) is to create a common European language for sustainable buildings, which includes the following:

- Macro objectives: A set of six macro objectives.
- Core indicators: A set of nine common indicators.
- Life cycle tools: A set of four scenario tools.
- Value and risk rating: A checklist and rating system to assess data quality.
- A reporting tool to collect data during the assessment.

Table 1 gives an overview of the six macro objectives along with the relevant core indicators and life cycle tools.

TABLE 1. Macro objectives, core indicators, and tools in Level(s)

Macro objectives	Core indicators and life-cycle tools
1. Greenhouse gas emissions along a building's life cycle	1.1 Indicator: Use-stage energy performance 1.2 Indicator: Life cycle global warming potential
2. Resource-efficient and circular material life cycle	2.1 Life cycle tools: Building bill of materials 2.2 Life cycle tools: Scenarios for building lifespan, adaptability and deconstruction • Scenario 1: Building and elemental service life planning • Scenario 2: Design for adaptability and refurbishment • Scenario 3: Design for deconstruction, reuse and recyclability 2.3 Indicator: Construction and demolition waste and materials 2.4 Life cycle tool: Cradle-to-cradle life cycle assessment
3. Efficient use of water resources	3.1 Indicator: Total water consumption
4. Healthy and comfortable spaces	4.1 Indicator: Indoor air quality 4.2 Indicator: Time outside of thermal comfort range
5. Adaptation and resilience to climate change	5.1 Indicator: Life cycle tools: scenarios for projected future climatic conditions
6. Optimised life cycle cost and value	6.1 Indicator: Life cycle costs 6.2 Indicator: Value creation and risk factors

In addition, Level(s) includes a reporting tool used to report values for all indicators and scenario calculations performed in connection with the assessment. In Level(s), the quality of all inventories related to the nine core indicators and the four life cycle tools is assessed.

This includes assessing the reliability of the data, the professional skills of the design team, and whether third-party independent verification has been performed.

The test phase of Level(s) is structured so that the total number of indicators and tools is divided into three levels for reporting requirements: minimum requirements (five requirements), recommended additional requirements (two requirements) and optional supplementary reporting requirements (seven requirements). In addition, Level(s) reporting is divided into three levels:

- Level 1: Minimum assessment, which uses a common European starting point for assessing the performance of buildings.
- Level 2: Comparison, where assessments of functionally equivalent buildings are compared according to common guidelines.
- Level 3: Optimisation, where assessments are conducted in more detail for variants of the specific building and building elements and for modelling future scenarios.

Level(s) have been tested in about 130 projects in 21 countries. For the testing phase, the following materials have been made available:

- Guidelines in the form of two technical reports and the associated life cycle tools from the European Commission's Joint Research Centre (JRC);
- Various guidance materials (e.g. a webinar and website);
- A reporting tool, a spreadsheet for entering results for indicators and scenario calculations; and
- A questionnaire survey to gather experience from the test projects.

The Danish Test Phase

The purpose of the analysis in this report is to evaluate the Danish experience with the use of Level(s) as a tool for documenting sustainable buildings. The analysis is based on data reporting for the test projects using the reporting tool, the responses to the EC JRC questionnaire, and the data collected from the four national evaluation workshops held in connection with the Danish test phase. The EC JRC questionnaire is the central point of evaluation of Level(s). The questionnaire focuses on three key aspects of the testing of Level(s):

- How useful was Level(s) in assessing the sustainability of the buildings?
- How did the design of Level(s) support the process of assessment?
- How user-friendly were the indicators and life cycle tools chosen together with their associated guides?

The Danish test phase included 18 Danish building cases, which consisted of seven office buildings and 11 residential buildings, four of which were existing buildings and 14 were new buildings. Of the four existing buildings, three were renovation projects, while one was a building in operation. Sixteen projects were reported to the European Commission as part of the overall European testing of Level(s), while two renovation projects were added to the Danish test phase during the evaluation to obtain a stronger representation of the particular challenges that may arise when using Level(s) in a renovation project. The distribution of project types is shown in Table 2 below.

TABLE 2. Distribution on project type versus building type

	Residential	Office
Existing building	3	1
New building	8	6

The evaluation was conducted from December 2018 to June 2019. None of the projects had the possibility to use Level(s) from the beginning of a project throughout all project phases due to the time constraints of the test process. The test was therefore conducted on ongoing projects or by looking back on completed projects. Together, the projects covered all the project phases evenly, as shown in Table 3.

TABLE 3. Distribution on project stages

Design stage	5
Construction	3
Completion and handover	6
Occupation	4

Expectations of Level(s) and Previous Experience

At the very beginning of the testing phase, the consultants were asked to explain their expectations of what Level(s) can be used for. Nearly all participants' expectations were that Level(s) would allow for a comparison between the assessment in Level(s) with either DGNB certification or future national regulation. They also expected Level(s) to provide them with information on whether sustainability goals had been achieved or could help set goals for the specific project. The responses are summarised in Table 4.

TABLE 4. Expectations when joining the test phase

Expectations	**Number of responses**
That it would provide information to establish objectives and targets for the sustainability of projects	10
That it would provide information to measure whether sustainability objectives and targets have been met	13
That it would provide information about the benefits of more sustainable buildings to clients/users	7
That it would provide information to avoid future risks (e.g. high carbon tax, high costs of renovation, low occupant satisfaction, and therefore high property void rates)	2
The possibility to compare a Level(s) assessment with assessments made using existing schemes (e.g. DGNB, HQE, BREEAM, etc.) or recent or forthcoming national regulation (e.g. in the Netherlands or France).	16
That it would provide information to support benchmarking and comparisons of the performance of different buildings	9
Other (please specify)	0

Multiple responses are possible.

However, at national evaluation workshops, the participants pointed out that the absence of actual benchmarks in Level(s) and the possibility for comparisons make it difficult to assess the actual project. In addition, participants pointed out that the extensive freedom of method in Level(s) means that it will be difficult to compare results between projects.

Participants were also asked to do a self-evaluation of their competencies and previous experiences in making similar assessments and documentation of the sustainability of

buildings. The self-evaluation showed that the Danish test phase was carried out by competent consulting teams with extensive experience, for example, in DGNB certification, conducting dynamic building simulations, life cycle assessment (LCA), and life cycle cost (LCC). The vast majority of project teams had extensive experience from the past, while only one team had no experience and one team had limited experience (Table 5).

TABLE 5. Previous experience

Previous experience	Number of responses
No previous experience	1
Limited previous experience (e.g. minimum energy/Energy Performance Certificate (EPC) requirements)	1
Some previous experience (e.g. simplified building simulations, comparisons of building materials based on environmental product declarations (EPDs), water use estimates)	3
Extensive previous experience (e.g. dynamic building simulations, LCA assessments, and building certification scheme assessments)	13

The experiences from the national evaluation workshops confirmed that extensive experience was required to carry out the reporting in Level(s). It was pointed out that the manual was difficult to understand, that it is very difficult to complete the reporting if one has not made a DGNB certification, and that Level(s) is not suitable for people without experience because Level(s) requires knowing the benchmarks to make several decisions within the process.

The Value of Level(s) to Key Stakeholders

The participants pointed out that Level(s) can create value for key stakeholders on a number of points, such as the following:

- The establishment of common European terminology and a platform for sustainable buildings;
- A less demanding alternative to an actual DGNB certification, for example;
- A driving force for a change in the building sector, including influence on public regulation;
- Improvement of performance and future-proofing buildings;
- The strengthening of the data quality as a basis for decision-making;
- The possibility of adaptation to different levels of ambition;
- A basis for a strengthened dialogue on sustainable goals and means; and
- An increased focus on the importance of building materials.

However, the participants also expressed a number of reservations that could reduce or eliminate value creation for key stakeholders. The list of these challenges includes the following:

- The need for a massive overhaul and improvement of both the manual and reporting tools;
- The absence of benchmarks/values for comparison purposes;
- The need for strong competencies;
- The unclear purpose of the system, especially in relation to the use of Level(s) for dialogue versus calculation, and certification versus reporting;
- A high degree of complexity in the definition of levels along two dimensions, that is, Levels 1-3 versus the requirements for which indicators and tools are used (minor, recommended and additional);

- Need for adjustments to be applicable to smaller renovation projects; and
- Need for a broader approach to sustainability, which includes social sustainability, for example.

Furthermore, it was clear from the national evaluation workshops that the extended method of freedom in Level(s) can add value and yet be challenging for stakeholders.

Design of Level(s)

The Danish participants indicated in the questionnaire survey that the current design of Level(s) provides no or limited support for the work on building sustainability in their projects in relation to setting sustainability goals, obtaining practical information on the building's sustainable performance, or focussing on measuring the current performance of a building in use (Table 6).

TABLE 6. Assessment of the design of Level(s)

	Not at all	Limited extent	Moderate extent	Great extent	Very great extent	Not relevant to this test
To what extent did Level(s) help you and your team to obtain practical information on the sustainability performance of the test building?	4	9	2	1		
To what extent did Level(s) help you and your team to identify design performance improvement measures?	4	6	2	1		3
To what extent did Level(s) help you and your team to set sustainability objectives and targets for the performance of the test building?	7	4	3	1		1
If you used Level(s) already in the planning stage, to what extent is the data collected for Level(s) the same as that needed for building permits?		2	1			12
To what extent did Level(s) help in focussing on the monitoring of the actual performance of an occupied building?	5	3	3			5

The questionnaire was supplemented with gathering experiences through national evaluation workshops. The experiences from the workshops indicated that the manual and tools should be integrated more closely with each other. It was also pointed out that the manual should be simplified and made easier to navigate, both visually and linguistically. It was noted that in its current form it is too difficult to obtain an overview because it is written in a complicated technical language, it contains many overlaps and repetitions, and it lacks examples and figures for easier understanding. Likewise, the ease of use of the reporting tool should be improved. The structure should be simplified and adapted to the actual workflow of projects. It should also provide feedback through a reporting key to monitor performance, graphically visualise results, manage and prepare documentation in a more structured way, and possibly, include independent control of documentation.

There were different opinions about the usability and value of the three levels offered by the system (i.e. Levels 1, 2 and 3). About 50% found usability moderate, while 35% found no or limited value and only 15% found great value. The complexity of Level 1 does not match the aim for Level 1 to be used by people without prior knowledge of the system. The workshops provided various suggestions for changes in the way the three levels could be used. Among others, it was proposed to make the system more dialogue-oriented and user-

friendly by simplifying Level 1 and saving some of the topics requiring more calculation for Levels 2 and 3.

Danish Experiences with the Use of Indicators and Life Cycle Tools

During the test phase, the Danish projects should test at least the five minimum requirements plus at least two additional optional requirements. In addition, the level chosen for reporting was optional. The tendency from the test was that the vast majority of projects alone reported on a total of seven requirements (the five minimum requirements plus two additional requirements), and they chose Level 1 reporting. This means that the data material for the analysis conducted on experiences using indicators and life-cycle tools are greatest for the five minimum requirements of the test and on Level 1. However, there are some exceptions; for example, 10 projects have tested the requirements for LCC, and six of these projects have tested LCC on Level 3.

TABLE 7. Distribution on Level(s) reporting requirements

	Level 1	Level 2	Level 3	N/A
The Level(s) test minimum reporting requirements				
1.1 Use-stage energy consumption	11	5	2	0
2.3 Construction and demolition waste and materials	12	4	1	1
3.1 Use-stage water consumption	9	7	1	1
4.1 Indoor air quality	12	1	5	0
4.2 Time out of the thermal comfort range	9	4	5	0
Recommended in addition to the Level(s) test minimum reporting requirements				
1.2 Life cycle global warming potential (GWP)	3	4	1	10
2.1 Life cycle tool: building bill of materials (BoM)	1	2	1	14
The Level(s) test optional additional reporting				
2.2 Life cycle tool: Scenario 1 – Building and elemental service life planning	2	2	0	14
2.2 Life cycle tool: Scenario 2 – Design for adaptability and refurbishment	4	2	0	12
2.2 Life cycle tool: Scenario 3 – Design for deconstruction, reuse and recycling	5	2	0	11
2.4 Life cycle tool: Cradle-to-cradle life cycle assessment (LCA)	3	3	0	12
5.1 Life cycle tool: Scenario 1 – Protection of occupier health and thermal comfort	4	0	2	12
6.1 Life cycle cost (LCC)	3	1	6	8
6.2 Value creation and risk factors	4	0	0	14

Minimum requirements

The minimum requirements in Level(s) contain three requirements that are already fully or partially included in the building regulations: the calculation of operating energy consumption, indoor air quality and time outside of the thermal comfort range. Work on these requirements, in particular, operational energy consumption and time outside the thermal comfort range, has therefore generally been relatively easy to access because data

have been available in some form and teams have had experience handling the documentation. With the requirement for indoor air quality, teams that have worked with DGNB certification of the particular project have helped with experience and data.

The other two minimum requirements (construction and demolition waste and water consumption) are both part of the DGNB certification, which has helped the test projects that were already DGNB certified. When calculating water consumption, there was greater similarity between Level(s) and DGNB reporting than for the construction waste indicator, which meant the work with the construction waste indicator was a little more challenging.

Recommended additional requirements

The recommended additional requirements for the minimum requirements in Level(s) include two requirements: the global warming potential and bill of materials. None of the requirements are part of the building regulations. The requirement for assessing contributions to global warming is part of performing LCA in a DGNB certification. Therefore, the teams that have worked with DGNB are familiar with the process and how to carry out calculations in LCAbyg or similar, while this has been completely new to other project teams that have not worked with DGNB certification. Level(s) provides various options for performing an LCA calculation including extending the system boundaries, which are different from the system boundary used in LCAbyg and DGNB. It has given some test participants some challenges by reporting exactly as Level(s) has specified.

The work on the bill of quantities was only tested in four projects but apparently has been carried out by projects that have worked with DGNB certification and thus performed an LCA and LCC calculation. It appears that the results were relatively easy to obtain because data could be obtained from these LCA and LCC calculations.

Optional additional reporting

This section includes seven different indicators or life-cycle tools. None of them are part of the building regulations, whereas most are part of DGNB certification in some form, although the reporting format is not necessarily the same. For the requirements under the optional additional reporting, project teams with experience from DGNB certification, and thus the use of tools LCAbyg and LCCbyg, have not generally had significant challenges with the process itself but most often indicate that the manual is inadequate.

This includes Life cycle tool 2.2, which has three scenario options. Data for using the first tool, building and elemental service-life planning, could be obtained directly from DGNB certification or LCAbyg, and it did not appear to cause major problems for the four design teams who tested this. The use of the second tool, design for adaptability and refurbishment, also did not cause major problems for the six design teams who tested this, and here again, this refers to the execution of LCA and DGNB criteria. The third tool, design for deconstruction, reuse and recyclability, caused a few more problems, although reference here was also to LCA tools and DGNB certification. However, it was mentioned that, if DGNB certification has been performed, it can be reported directly to both Levels 1 and 2. Challenges to the latter-mentioned life cycle tool are primarily related to inexperience by the design team, which indicates that those who have worked with DGNB find it relatively easy to report, whereas those who have not had experience have a harder time with it.

Life cycle tool 2.4, cradle-to-cradle LCA has been tested in five projects. The requirement is to perform an LCA, which includes other environmental impact categories in addition to global warming, which is included as a separate indicator (1.2). In LCAbyg, all environmental impact categories are automatically calculated; therefore, the same work is performed by performing 1.2 and 2.4. The participants did not experience major challenges because they have relatively good experience working with LCA but again mentioned that, in some scenarios, the system boundary for the calculations may differ from system

boundaries in LCAbyg and what is included in the DGNB. They also mention the bias in Level(s) requirements in relation to the European standards used in Denmark for the implementation of LCA.

In Life Cycle Tool 5.1, scenarios for projected future climatic conditions, the protection of occupants' health and thermal comfort is not normally used in ordinary Danish practice or in DGNB certification. The number of projects that included this indicator was about one-third of the test projects. They did, however, have good experience highlighting the effect of climate change on thermal comfort, not the least in relation to demonstrating a sharp increase in the time outside the thermal comfort range with the need for more cooling in the future to comply with the current indoor climate requirements.

The 6.1 Life cycle costs (LCC) indicator was used by more than half of the test projects at various levels. Most of the respondents have had some or substantial experience with LCC from previous projects, and they had easy access to data from DGNB certification and the use of LCCbyg. The majority of respondents did not find the manual adequate and instead suggested using LCCbyg and DGNB certification. The second indicator under macro Objective 6 is the indicator for 6.2, value creation and risk factors. This indicator has only been tested by a few respondents and only at Level 1. Although previous experience of working with the indicator is small, the majority of respondents found the indicator easy to work with.

Renovations

Finally, the analysis of experience from the test of Level(s) has examined whether conditions exist in renovation projects that require special attention in relation to the further development and possible implementation of Level(s). This was a particular theme at the fourth and final evaluation workshop, where participants pointed out a number of opportunities and challenges that Level(s) in its current form is facing. The opportunities and challenges can be summarised as follows:

- Renovation projects require knowledge of the existing conditions, which could take the form of a baseline registration of screening for environmentally hazardous substances (such as asbestos and PCBs), indoor climate conditions (such as moisture and mould), measurement of consumption for supply, condition assessment of building parts, assessment of recycling options, and so on.
- In its current form, Level(s) is primarily aimed at major renovations, which similar to new construction, but adaptation to smaller and simpler renovation projects is needed.
- The six current macro objectives may provide more value when renovating than new construction because comparing the conditions before and after a renovation can be better treated and made visible, for example, in the form of savings in operations.
- However, the six current macro objectives also present greater challenges in renovation than new construction. Because the focus is typically directed solely at what is being replaced and not the entire building, it may be difficult to obtain data for existing constructions. Further, the requirements for the thermal indoor climate will be even more difficult to meet in 2030 and 2050 than today, and uncertainties are greater.
- A number of new macro targets or extensions of the current six macro objectives have been called for by the participants, among others, social sustainability, outdoor areas, user involvement, daylight and acoustics, safety and robustness (including fire), building heritage, architectural quality and climate adaptation (e.g. regarding increased rainfall and flooding).

DANSK SAMMENFATNING

Om Level(s)

Europakommissionen har lanceret Level(s), som er en fælles europæisk ramme for måling og rapportering af bæredygtighed ved nybyggeri og gennemgribende renoveringer af boliger og kontorer. Level(s) består af et sæt af kerneindikatorer og fælles metrikker til måling af bygningers bæredygtighed over deres livscyklus. Formålet med Level(s) er at skabe et fælles europæisk sprog for bæredygtige bygninger, der inkluderer (se Tabel 1):

- Makromål: Et sæt af seks makromål.
- Kerneindikatorer: Et sæt af ni fælles indikatorer.
- Livscyklusværktøjer: Et sæt af fire scenarie-værktøjer.
- Værdi og risikovurdering: En checkliste til vurdering af datakvalitet.
- Rapporteringsværktøj.

TABEL 1. Makromål, kerneindikatorer og livscyklusværktøjer i Level(s)

Makromål	**Kerneindikatorer og livsycklusværktøjer**
1. Drivhusgasemissioner over bygningens livscyklus.	1.1 Indikator: Driftsenergiforbrug 1.2 Indikator: Global opvarmningspotentiale over bygningens livscyklus
2. Ressourceeffektive og cirkulære materialecyklusser.	2.1 Livscyklusværktøj: Materialeopgørelse 2.2 Livscyklusværktøj: Scenarier for bygningens levetid, tilpasningsevne og nedrivning • Scenario 1: Planlægning af levetider for bygningen og bygningsdele • Scenario 2: Design for fleksibilitet og renovering • Scenario 3: Design for adskillelse, genbrug og genanvendelse 2.3 Indikator: Bygge- og anlægsaffald 2.4 Livscyklusværktøj: Vugge-til-vugge livscyklusvurdering (LCA
3. Effektiv brug af vandressourcer.	3.1 Indikator: Vandforbrug
4. Sunde og komfortable bygninger.	4.1 Indikator: Indendørs luftkvalitet 4.2 Indikator: Brugstid uden for termisk komfort
5. Tilpasning og robusthed over for klimaforandringer.	5.1 Indikator: Livscyklusværktøjer: Scenarier for fremtidige klimaforhold – Beskyttelse af beboernes sundhed og termisk komfort
6. Optimeret totaløkonomi og værdiskabelse.	6.1 Indikator: Totaløkonomi (LCC). 6.2 Indikator: Værdiskabelse og risikofaktorer

Derudover omfatter Level(s) et rapporteringsværktøj, der benyttes til at rapportere værdier for alle indikatorer og scenarie-beregninger, som udføres i forbindelse med Level(s).

I Level(s) udføres en vurdering af kvaliteten for alle opgørelser, der vedrører de 9 kerneindikatorer og de 4 livscyklusværktøjer. Denne del inkluderer vurdering af datas pålidelighed, designteamets professionelle kompetencer og om der er udført tredjeparts uafhængig verificering.

Testfasen af Level(s) er bygget således op, at det samlede antal indikatorer og værktøjer er delt op i 3 niveauer for rapporteringskrav, nemlig minimumskrav (5 krav), anbefalede tillægskrav (2 krav) og valgfri supplerende rapporteringskrav (7 krav). Derudover er rapporteringen i Level(s) delt op i tre niveauer:

- Level 1: Minimumsvurdering – som bruger et fælles europæisk udgangspunkt til vurdering af bygningers ydeevne.
- Level 2: Sammenligning – hvor vurderinger af funktionelt ækvivalente bygninger sammenlignes efter fælles retningslinjer.
- Level 3: Optimering – hvor vurderinger udføres mere detaljeret for varianter af den konkrete bygning og bygningsdele samt modellerer fremtidige scenarier.

Level(s) er blevet testet i omkring 130 projekter i 21 lande. Til testfasen er der stillet følgende til rådighed for projekterne:

- Guidelines i form af to tekniske rapporter med tilhørende livscyklusværktøjer fra Europa-Kommissionens Joint Research Center (JRC).
- Diverse vejledningsmaterialer fx webinar og hjemmeside.
- Rapporteringsværktøj – et regneark til indtastning af resultater for indikatorer og scenarie-beregninger.
- Spørgeskemaundersøgelse til opsamling af erfaringer fra testen.

Det danske testforløb

Formålet med SBi's analyse har været at evaluere de danske erfaringer med brugen af Level(s) som et redskab til dokumentation af bæredygtige bygninger. Analysen er baseret på indberetning af data i rapporteringsværktøjet, testprojekternes udfyldelse af EU JRC's spørgeskemaundersøgelse og data indsamlet i forbindelse med afholdelse af 4 nationale evalueringsworkshops.

Spørgeskemaundersøgelsen fra EU JRC har været det centrale udgangspunkt for evalueringen af Level(s). Spørgeskemaet fokuserer på tre centrale aspekter ved testen af Level(s):

- Hvor nyttigt var Level(s) til vurdering af bygningernes bæredygtighed?
- Hvordan understøttede udformningen af Level(s) processen for vurderingen?
- Hvor brugervenlig var de valgte indikatorer og livscyklusværktøjer sammen med deres tilhørende vejledninger?

Det danske testforløb omfattede 18 danske byggesager, der bestod af 7 kontorbygninger og 11 boliger, hvoraf 4 var eksisterende bygninger og 14 nybyggerier. Af de 4 eksisterende bygninger var 3 renoveringsprojekter, mens 1 var en bygning i drift. 16 projekter blev rapporteret til Europa-Kommissionen som en del af den samlede europæiske test af Level(s), mens 2 renoveringsprojekter blev tilføjet under evalueringen for at få en stærkere repræsentation af de særlige udfordringer, der kan opstå ved anvendelse af Level(s) i et renoveringsprojekt (se Tabel 2).

TABEL 2. Fordeling af testprojekter

	Bolig	Kontor
Eksisterende bygning	3	1
Nybyggeri	8	6

Evalueringen blev gennemført i perioden december 2018 til juni 2019. Ingen af projekterne har haft mulighed for at kunne anvende Level(s) fra begyndelsen af et projekt og igennem et helt projektforløb pga. de tidsmæssige restriktioner på testforløbet. Testen blev derfor udført på igangværende projekter eller som et tilbageblik på afsluttede projekter. Tilsammen har projekterne dækket alle projektfaserne nogenlunde ligeligt (se Tabel 3).

TABEL 3. Fordelingen mellem projekt faser

Design fase	5
Anlægsfase	3
Afleveringsfase	6
Brugsfase	4

Forventninger til Level(s) og tidligere erfaring

Ved opstarten af testfasen inden rådgiverne for alvor begyndte at arbejde med Level(s), blev de bedt om at redegøre for deres forventninger til, hvad Level(s) kan bruges til. Nærmest samtlige deltagerse forventninger var, at Level(s) ville give mulighed for en sammenligning mellem vurderingen i Level(s) med enten DGNB certificering eller fremtidig national regulering. De forventede også, at Level(s) ville give dem information om, hvorvidt bæredygtighedsmål er nået eller kan hjælpe til at sætte mål for det konkrete projekt (se Tabel 4).

TABEL 4. Forventninger til Level(s) ved opstarten af testfasen

Forventninger	**Svar**
Muligheden for at sammenligne en vurdering i Level(s) med vurderinger foretaget ved hjælp af eksisterende ordninger (f.eks. DGNB, HQE, BREEAM osv.) Eller med nylig eller kommende national regulering (f.eks. i Holland eller Frankrig).	16
At det giver information til måling af om bæredygtighedsmål er nået	13
At det giver information til at fastlægge formål og mål for projekternes bæredygtighed	10
At det ville give oplysninger til støtte for benchmarking og sammenligninger af ydeevnen i forskellige bygninger	9
At det vil give oplysninger om fordelene ved mere bæredygtige bygninger til klienter/brugere	7
At det giver information for at undgå fremtidige risici (f.eks. høj CO_2-afgift, høje omkostninger til renovering, lav tilfredshed blandt beboerne og derfor høje tomgangsudgifter)	2

Imidlertid påpegede deltagerne ved de afholdte workshops, at fraværet af egentlige benchmarks i Level(s) og dermed et sammenligningsgrundlag, vanskeliggør en bedømmelse af det aktuelle projekt. Desuden pegede deltagerne på, at den udstrakte metodefrihed i Level(s) betyder, at det bliver svært at sammenligne resultater mellem flere projekter.

Deltagerne blev også bedt om at lave en selvevaluering af deres kompetencer og tidligere erfaringer med at lave lignende vurderinger og dokumentation af bygningers bæredygtighed. Selvevalueringen viste, at det danske testforløb blev udført af kompetente rådgiverteams med omfattende erfaring med fx DGNB-certificering, udførelse af dynamiske bygningssimuleringer, LCA og LCC. Det store flertal af projektteams havde omfattende erfaring fra tidligere, mens kun ét enkelt team ingen erfaring havde, og ét enkelt team havde begrænset erfaring (se Tabel 5).

TABEL 5. Rådgiverteams tidligere erfaring

Tidligere erfaring	Svar
Ingen tidligere erfaring	1
Begrænset tidligere erfaring (f.eks. krav til energiforbrug i bygninger)	1
Nogle tidligere erfaringer (f.eks. forenklede bygningssimuleringer, sammenligninger af byggematerialer baseret på miljøvaredeklarationer (EPD'er), estimat af vandforbrug)	3
Omfattende tidligere erfaring (f.eks. dynamiske bygningssimuleringer, LCA-vurderinger, certificering)	13

Opsamling af erfaringer fra de nationale evalueringsworkshop bekræftede, at omfattende erfaring var nødvendig for at kunne gennemføre rapportering i Level(s). Her blev det blandt andet påpeget, at manualen var svær at forstå, at det er meget svært at gennemføre hvis man ikke har lavet DGNB-certificering el.lign., og at Level(s) ikke egner sig til personer uden nogen form for erfaring, da Level(s) kræver at man kender benchmarks selv, for at valg kan træffes i processen.

Værdien af Level(s) for de vigtigste interessenter

Testdeltagerne pegede på, at Level(s) kan være værdiskabende for de vigtigste interessenter på en række punkter, såsom:

- Etablering af en fælles europæisk terminologi og platform for bæredygtigt byggeri.
- Et mindre krævende alternativ til fx en egentlig DGNB-certificering.
- En drivkraft for forandring i byggeriet, herunder indflydelse på den offentlige regulering.
- Forbedring af ydeevne og fremtidssikring af byggeri.
- Styrkelse af datakvaliteten som grundlag for beslutningsprocessen.
- Mulighed for tilpasning til forskellige ambitionsniveauer.
- Grundlag for en styrket dialog om bæredygtige mål og midler.
- Et øget fokus på betydningen af byggematerialer.

Testdeltagerne gav dog også udtryk for en række reservationer, som kan reducere eller fjerne værdiskabelsen for de vigtigste interessenter. Listen over disse udfordringer omfatter blandt andet:

- Behov for en massiv revision og forbedring af både manual og rapporteringsværktøj.
- Fraværet af benchmarks / nøgletal til brug for sammenligning.
- Stærke kompetencer er nødvendige.
- Formål med systemet er for uklart, især i relation til brugen af Level(s) til henholdsvis dialog kontra beregning og certificering kontra rapportering.
- En høj grad af kompleksitet i definitionen af niveauer langs to dimensioner, dvs. Levels 1-3 kontra krav til hvilke indikatorer og værktøjer der anvendes.
- Behov for tilpasninger for at være anvendelig på mindre renoveringsprojekter.
- En bredere tilgang til bæredygtighed, som også omfatter fx social bæredygtighed.

Desuden stod det klart fra de afholdte workshop, at den udstrakte metodefrihed i Level(s) kan være både værdiskabende og en udfordring for interessenterne.

Udformning af Level(s)

De danske deltagere har i spørgeskemaundersøgelsen tilkendegivet, at den nuværende udformning af Level(s) giver ingen eller begrænset støtte i arbejdet med bæredygtighed i deres byggeprojekter i forhold til at opstille bæredygtighedsmål, at få praktiske oplysninger om bygningens bæredygtige ydeevne eller at fokusere på måling af den aktuelle ydeevne af en bygning i brug (se Table 6).

TABEL 6. Vurdering af udformning af Level(s)

	Slet ikke	Begrænset omfang	Moderat omfang	Stort omfang	Meget stort omfang	Ikke relevant for denne test
I hvilket omfang hjalp Level(s) dig og dit team med at få praktiske oplysninger om testbygningens bæredygtighedspræstationer?	4	9	2	1		
I hvilket omfang hjalp Level(s) dig og dit team med at identificere forbedringsforanstaltninger til design?	4	6	2	1		3
I hvilket omfang hjalp Level(s) dig og dit team med at opstille bæredygtighedsmål for udførelsen af testbygningen?	7	4	3	1		1
Hvis du allerede anvendte Level(s) i planlægningstrinnet, i hvilket omfang er dataene indsamlet for Level(s) de samme som de nødvendige for byggetilladelser?		2	1			12
I hvilket omfang hjalp Level(s) med at fokusere på måling af den aktuelle performance af en bygning i brug?	5	3	3			5

Spørgeskemaundersøgelsen blev suppleret med erfaringer fra workshops, som pegede på, at manualen og værktøjerne bør integreres tættere med hinanden. Det blev også påpeget, at manualen bør forenkles og være lettere at navigere i både visuelt og sprogligt, da den i sin nuværende form er for vanskelig at få et overblik over, skrevet i et kompliceret teknisk sprog, indeholder mange overlap og gentagelser samt savner eksempler og grafik til lettere forståelse. Ligeledes bør brugervenligheden af rapporteringsværktøjet forbedres, strukturen forenkles, tilpasses til den faktiske arbejdsgang af projekter, give feedback gennem en rapporteringsnøgle for at føre tilsyn med resultatresultatet, visualisere resultater grafisk, håndtere og udarbejde dokumentation mere struktureret og eventuelt indeholde uafhængig kontrol af dokumentation.

Der var delte meninger om brugbarheden og værdien af de tre niveauer, som systemet tilbyder, dvs. Level 1, 2 og 3. Omkring 50 % fandt brugbarheden moderat, mens 35 % fandt ingen eller begrænset værdi og kun 15 % fandt stor værdi. Kompleksiteten matcher ikke ambitionen om, at Level 1 skal kunne bruges af folk uden forudgående kendskab til systemet. De afholdte workshops gav forskellige forslag til ændringer af den måde, som de 3 niveauer kunne anvendes på. Her blev der blandt andet. foreslået at gøre systemet mere dialogorienteret og brugervenligt ved at simplificere Level 1 og gemme nogle af de mere beregningsmæssige emner til Level 2 og 3.

Danske erfaringer ved brug af indikatorer og livscyklusværktøjer

I testfasen skulle de danske projekter som minimum afprøve de fem minimumskrav plus mindst 2 valgfrie krav. Derudover var det valgfrit hvilket niveau, de valgte for rapporteringen. Tendensen fra afprøvningen var, at langt de fleste projekter alene rapporterede på i alt 7 krav (de 5 minimumskrav plus 2 ekstra krav), og at de valgte rapportering på Level 1. Det betyder, at datamaterialet for den udførte analyse på erfaringer ved brug af indikatorer og livscyklusværktøjer er størst for henholdsvis testens fem minimumskrav og for Level 1. Der er dog nogle undtagelser, fx har i alt 10 projekter testet kravene om LCC, hvoraf 6 projekter har testet på Level 3 (se Tabel 7).

TABEL 7. Fordelingen i rapporteringen i den danske testfase (antal projekter i alt 18)

	Level 1	Level 2	Level 3	N/A
Level(s) testfasens minimumskrav				
1.1 Driftsenergiforbrug	11	5	2	0
2.3 Bygge- og anlægsaffald	12	4	1	1
3.1 Vandforbrug	9	7	1	1
4.1 Indendørs luftkvalitet	12	1	5	0
4.2 Brugstid uden for termisk komfort	9	4	5	0
Anbefalet i tillæg til minimumkravene				
1.2 Potentiale for global opvarmning over bygningens livscyklus	3	4	1	10
2.1 Livscyklusværktøjer: Materialeopgørelse	1	2	1	14
Valgfri ekstra rapportering				
2.2 Værktøj Scenario 1: Planlægning af levetider for bygningen og bygningsdele	2	2	0	14
2.2 Værktøj Scenario 2: Design for fleksibilitet og renovering	4	2	0	12
2.2 Værktøj Scenario 3: Design for adskillelse, genbrug og genanvendelse	5	2	0	11
2.4 Livscyklusværktøjer: Vugge til vugge livscyklusvurdering (LCA)	3	3	0	12
5.1 Scenarier for forventede fremtidige klimaforhold: Beskyttelse af beboernes sundhed og termisk komfort	4	0	2	12
6.1 Totaløkonomi (LCC)	3	1	6	8
6.2 Værdiskabelse og risikofaktorer	4	0	0	14

Minimumskrav

Minimumskravene i Level(s) indeholder 3 krav, som i forvejen indgår helt eller delvist i bygningsreglementet, nemlig *opgørelse af driftsenergiforbrug*, *indendørs luftkvalitet* og *brugstid uden for termisk komfort*. Arbejdet med disse krav, især *driftsenergiforbrug* og *brugstid uden for termisk komfort*, har derfor generelt været forholdsvis let at gå til, idet data har foreligget i en eller anden form, og der har været erfaringer hos teamet til at håndtere dokumentationen. Ved kravet om *indendørs luftkvalitet* har arbejdet med DGNB hjulpet til med erfaringer og data.

De øvrige 2 minimumskrav (hhv. *bygge- og anlægsaffald* og *vandforbrug*) er en del af DGNB-certificeringen, hvilket har hjulpet de testprojekter, der allerede var DGNB-certificerede. Ved opgørelse af *vandforbruget* var der større lighed mellem rapporteringen i

Level(s) og DGNB end for indikatoren for *bygge- og anlægsaffald*, hvilket betød at fokus på affald var lidt mere udfordrende.

Anbefalet i tillæg til minimumskrav

De anbefalede tillægskrav til minimumskravene i Level(s) indebærer 2 krav, nemlig *potentiale for global opvarmning* og *materialeopgørelse*. Ingen af kravene er en del af bygningsreglementets krav. Kravet om vurdering af bidrag til global opvarmning er en del af udførelsen af LCA ved en DGNB-certificering. Derfor har de teams, der har arbejdet med DGNB, haft kendskab til processen og håndtering af beregninger i fx LCAbyg, mens dette har været helt nyt for andre projektteams. Level(s) lægger op til forskellige muligheder for at udføre en LCA-beregning blandt andet. ved at udvide systemgrænserne i forhold til den måde, som LCA-beregninger udføres i LCAbyg og DGNB. Det har givet nogle testdeltagere udfordringer med at rapportere præcist, som Level(s) har specificeret.

Arbejdet med *materialeopgørelsen* blev kun testet i 4 projektteams, men tilsyneladende udført af projekter, der har arbejdet med DGNB-certificering og dermed udført en LCA- og en LCC-beregning. Her fremgår det, at resultater var forholdsvis nemme at opnå, fordi data kunne indhentes fra disse LCA- og LCC-beregninger.

Valgfri ekstra rapportering

Denne del indebærer 7 forskellige indikatorer eller livscyklusværktøjer. Ingen af dem er en del af bygningsreglementet, mens de fleste er en del af DGNB-certificering i en eller anden form, selvom rapporteringsformatet ikke nødvendigvis er det samme. For kravene under valgfri ekstra rapportering kan det generelt konstateres, at projektteams med erfaring fra DGNB-certificering og dermed brug af værktøjer LCAbyg og LCCbyg ikke har haft de store udfordringer med selve processen, men oftest peger på, at manualen er mangelfuld.

Her indgår et livscyklusværktøj (2.2), som har tre scenariomuligheder. Data for brug af det første værktøj, *Planlægning af levetider for bygningen og bygningsdele*, kunne indhentes direkte fra DGNB-certificering eller LCAbyg, og det gav tilsyneladende ikke de store problemer hos de 4 designteams, der afprøvede dette. Anvendelsen af det andet værktøj, *Design for fleksibilitet og renovering*, gav heller ikke store problemer hos de 6 designteams, som afprøvede dette og her henvises igen til udførelse af LCA og DGNB-kriterier. Det tredje værktøj, *Design for adskillelse, genbrug og genanvendelse*, voldte lidt flere problemer, selvom der også her henvises til LCA-værktøjer og DGNB-certificering. Her nævnes dog, at hvis der er udført DGNB-certificering, kan der rapporteres direkte til både Level 1 og 2. Som udfordringer til den sidstnævnte nævnes hovedsagelig manglende erfaring hos designteamet, hvilket tyder på, at dem der har arbejdet med DGNB har forholdsvis nemt med at rapportere, mens dem der ikke har, har sværere ved det.

Livscyklusværktøj 2.4, *Vugge til vugge livscyklusvurdering (LCA*), er afprøvet i 5 projekter. Kravet handler om at udføre en LCA som beregner flere miljøpåvirkningskategorier end kun den globale opvarmning, som i Level(s) er et særskilt krav (1.2). I LCAbyg beregnes automatisk alle miljøpåvirkningskategorier, og derfor udføres samme arbejde ved at udføre 1.2 og 2.4. Deltagerne har ikke oplevet store udfordringer, idet de har forholdsvis god erfaring med udførelse af LCA, men nævner igen at systemgrænsen for beregningerne i nogle scenarier kan afvige fra systemgrænser i LCAbyg og hvad, der indgår i DGNB. De nævner også skævheder i kravene i Level(s) i forhold til de europæiske standarder der bruges i Danmark til udførelse af LCA.

Livscyklusværktøjet *5.1 Scenarier for forventede fremtidige klimaforhold: Beskyttelse af beboernes sundhed og termisk komfort* anvendes normalt ikke i almindelig dansk praksis eller ved DNGB-certificering. Antallet af afprøvninger har kun omfattet en tredjedel af testprojekterne, som imidlertid har haft gode erfaringer med at synliggøre effekten af klimaforandringer på den termiske komfort, ikke mindst i relation til at demonstrere en kraftig

forøgelse af brugstiden med behov for køling i fremtiden for at overholde nugældende indeklimakrav.

Indikatoren for *6.1 Totaløkonomi (LCC)* blev anvendt af mere end halvdelen af testprojekterne på forskellige niveauer. Hovedparten af respondenterne har nogen eller meget erfaring med LCC fra tidligere projekter, og de har haft let adgang til data fra DGNB-certificering og brug af LCCbyg. Størstedelen af respondenterne finder ikke manualen fyldestgørende, og foreslår i stedet at anvende LCCbyg og DGNB-certificering. Den anden indikator under makromål 6 er indikatoren for *6.2 Værdiskabelse og risikofaktorer*. Denne indikator er kun blevet testet af få respondenter og kun på Level 1. Selvom tidligere erfaring med at arbejde med indikatoren er lille, finder hovedparten af respondenterne indikatoren let at arbejde med.

Særlige udfordringer ved renovering

Afslutningsvist har analysen af erfaringer fra testen af Level(s) set nærmere på, om der er forhold ved renoveringsprojekter, som kræver særlig opmærksomhed i forhold til den videre udvikling, og eventuel implementering, af Level(s). Dette var et særligt tema ved den fjerde og sidste evalueringsworkshop, hvor deltagerne pegede på en række muligheder og udfordringer, som Level(s) i sin nuværende form vanskeligt imødekommer. Mulighederne og udfordringerne kan opsummeres på følgende vis:

- Renoveringsprojekter fordrer kendskab til de eksisterende forhold, hvilket kunne ske i form af en baseline registrering af fx screening for miljøfarlige stoffer som asbest og PCB, indeklimaforhold fx fugt og skimmel, måling af forbrug til forsyning, tilstandsvurdering af bygningsdele og vurdering af genbrugsmuligheder mv.
- Level(s) er i sin nuværende form primært rettet mod større og gennemgribende renoveringer, som tilnærmelsesvis har karakter af nybyggeri, men der er behov for en tilpasning til mindre og enklere renoveringsprojekter.
- De 6 nuværende makromål giver muligvis mere værdi ved renovering end nybyggeri, fordi sammenligning af forholdene før og efter en renovering bedre kan behandles og synliggøres fx i form af besparelser på driften.
- De 6 nuværende makromål rummer dog også større udfordringer ved renovering end nybyggeri, blandt andet. fordi fokus typisk er rettet alene mod det der udskiftes og ikke hele bygningen, det kan være vanskeligt at skaffe data for eksisterende konstruktioner, kravene til det termiske indeklima vil blive endnu vanskeligere at imødekomme i 2030 og 2050 end i dag, og usikkerhedsfaktorer er større.
- En række nye makromål, eller udvidelser af de nuværende 6 makromål er blevet efterlyst af deltagerne blandt andet social bæredygtighed, udearealer, brugerinvolvering, dagslys og akustik, sikkerhed og robusthed herunder brand, bygningsarv, arkitektonisk kvalitet og klimatilpasning fx vedr. øget nedbør og oversvømmelser.

1

INTRODUCTION

1 INTRODUCTION

The European Commission has launched Level(s), which is a common European framework for measuring and reporting sustainability for new construction and major renovations of residential buildings and offices. Level(s) consists of a set of core indicators and common metrics for measuring the sustainability of buildings over their life cycle. The purpose of Level(s) is to create a common European language for sustainable buildings, which includes (JRC – Joint Research Centre, European Commission (2017a & 2017b):

- Macro objectives: A set of 6 macro objectives.
- Core indicators: A set of 9 common indicators.
- Life cycle tools: A set of 4 scenario tools.
- Value and risk rating: A checklist and rating system to assess data quality.
- detail

TABLE 8. Macro objectives, core indicators and tools in Level(s)

Macro objectives	Core indicators and life cycle tools
1. Greenhouse gas emissions along a buildings life cycle	1.1 Indicator: Use stage energy performance 1.2 Indicator: Life cycle Global Warming Potential
2. Resource-efficient and circular material life cycle	2.1 Life cycle tools: Building bill of materials 2.2 Life cycle tools: scenarios for building lifespan, adaptability and deconstruction • Scenario 1: Building and elemental service life planning • Scenario 2: Design for adaptability and refurbishment • Scenario 3: Design for deconstruction, reuse and recyclability 2.3 Indicator: Construction and demolition waste and materials 2.4 Life cycle tool: Cradle to grave Life Cycle Assessment
3. Efficient use of water resources	3.1 Indicator: Total water consumption
4. Healthy and comfortable spaces	4.1 Indicator: Indoor air quality 4.2 Indicator: Time outside of thermal comfort range
5. Adaptation and resilience to climate change	5.1 Indicator: Life cycle tools: scenarios for projected future climatic conditions
6. Optimised life cycle cost and value	6.1 Indicator: Life cycle costs 6.2 Indicator: Value creation and risk factors

In addition, Level(s) includes a reporting tool used to report values for all indicators and scenario calculations performed in connection with the assessment.

In Level(s), the quality of all inventories related to the 9 core indicators and the 4 life cycle tools are assessed. This includes assessing the reliability of the data, the professional skills of the design team and whether third-party independent verification has been performed.

The EU Commission has invited practitioners to test Levels in 2018-2019 to qualify the further development of the system. The European test phase of Level(s) is structured so that

the total number of indicators and tools is divided into 3 levels for reporting requirements, namely minimum requirements (5 requirements), recommended additional requirements (2 requirements) and optional supplementary reporting requirements (7 requirements). In addition, Level(s) reporting is divided into three levels:

- Level 1: Minimum assessment – which uses a common European starting point for assessing the performance of buildings.
- Level 2: Comparison – where assessments of functionally equivalent buildings are compared according to common guidelines.
- Level 3: Optimization – where assessments are carried out in more details for variants of the specific building and building elements as well as modelling future scenarios.

Level(s) have been tested in about 130 projects in 21 countries. For the testing phase, the following projects have been made available:

- Guidelines in the form of two technical reports and associated life-cycle tools from the European Commission's Joint Research Center (JRC).
- Various guidance materials, e.g. webinar and website.
- Reporting tool – a spreadsheet for entering results for indicators and scenario calculations.
- Questionnaire survey to gather experience from the test projects.

1.1 The Danish test phase

The purpose of the analysis carried out in this report has been to evaluate the Danish experience with the use of Level(s) as a tool for documentation of sustainable buildings. The analysis is based on the test projects reporting of data in the reporting tool, their responses to the EU JRC questionnaire and data collected at four national evaluation workshops held in connection with the Danish test phase.

The EU JRC questionnaire has been the central point of evaluation of Level(s). The questionnaire focuses on three key aspects of the testing of Level(s):

- How useful was Level(s) in assessing the sustainability of the buildings?
- How did the design of Level(s) support the process of assessment?
- How user-friendly were the indicators and life-cycle tools chosen together with their associated guides?

The Danish test-phase included 18 Danish building cases, which consisted of 7 office buildings and 11 residential buildings, 4 of which were existing buildings and 14 new buildings. Of the 4 existing buildings, 3 were renovation projects, while 1 was a building in operation. Sixteen projects were reported to the European Commission as part of the overall European testing of Level(s), while two renovation projects were added to the Danish test-phase during the evaluation in order to get stronger representation of the particular challenges that may arise when using Level(s) in a renovation project.

The evaluation was conducted during the period December 2018 to September 2019. None of the projects had the possibility to use Level(s) from the beginning of a project and through an entire project due to the time constraints on the test process. The test was therefore carried out on ongoing projects or by looking back at completed projects. Together, the projects have covered all the project phases evenly.

Level(s) is tested in 18 Danish building projects, consisting of 7 office buildings and 11 residential buildings. Of those 18 projects, 15 cases are new buildings and 3 cases are renovation cases. 16 projects was reported to the European Commission as part of the test

of Level(s), while 2 renovation projects were added during the evaluation to get a stronger representation of the particular problems encountered if Level(s) were applied in a renovation project.

The aim of the Danish testing project was twofold:

Part 1: To evaluate the Danish experiences with the use of Level(s) as a tool for sustainable buildings by testing the system on 18 Danish building cases.

Part 2: Based on the experiences of the testing, to develop recommendations for further improvements of Level(s).

The evaluation took place from December 2018 to September 2019. This report documents the results of part 1, while the recommendations for further development is reported separately.

2

METHODOLOGY

2 METHODOLOGY

This chapter provides an overview of the 18 Danish building cases included in the test. Then follows a brief introduction to the EU Level(s) Assessment Matrix for building performance measurement as well as the EU Test Survey for feedback from the test. A description of the national evaluation process concludes the chapter.

2.1 Test in 18 Danish cases

An overview of the 18 test building projects is provided in Table 9 below with regard to the project name, location, building type, project stage and the responsible companies and contact persons. It should be noted that the 2 additional renovation projects added after the initiation of the evaluation have only filled in the evaluation survey and not the assessment matrix of the building performance as otherwise requested by the European Commission.

TABLE 9. Overview of test projects

Project name	Location	Type	Stage	Company	Contact person
Rolighedsvej	Ballerup	R	Con	AI	Tomas Snog
Sundmolen 5.05	Copenhagen	R	Hand	COWI	Allan Hesselholt
Almen Bolig +5	Copenhagen	R	Con	DEM	Jakob Rostgaard Dyring
Katrinebjerg Afd. 77	Aarhus	R	Des	Ekolab	Cathrine Riis
FBAB	Aarhus	R	Hand	D + W	Gitte Sejr Sørensen & Jens Peter Kragh
Nursing Home	Frederikssund	R	Des	Frandsen & Søndergaard	Lasse Hagerup
Greensquare Garden	Copenhagen	R	Hand	Aarstiderne	Brian Højbjerre Sørensen
BOLIG+	Søborg	R	Occ	MOE	Anne-Kirstine Holm
Ryesgade 25	Copenhagen	R	Hand	Krydsrum	Klaus Stub Dyhr
Sorgenfrivang II	Lyngby	R	Occ	DOMINIA	Charlotte Macher
Sødisbakke	Mariager	R	Occ	Rambøll	Gitte Gylling Hammershøj Olesen
Communal building for social-psychiatric homes	Aars	O	Hand	DOMINIA	Zeynel Palamutcu & Charlotte Marcher
MOE 2 HQ	Copenhagen	O	Des	MOE	Karoline Geneser
Ny Kærvang	Nykøbing Mors	O	Occ	Rambøll	Christine Collin & Gitte Gylling Hammershøj Olesen
Ørestad City I	Copenhagen	O	Hand	SWECO	Camilla Dyring & Henriette Menå Grud
Vibenshus Runddel	Copenhagen	O	Des	EKJ	Morten Zimmermann
Nordfyns Bank HQ	Odense	O	Con	Arkitema	Signe Bang Korsnes
Rockwool International HQ	Hedehusene	O	Occ	Rockwool	Magdalini Psarra & Agnes Schuurmans

The 18 Danish building projects are distributed on residential, office, mixed-use and others, as shown in Table 10. The table shows that there is a slight overweight of residential buildings compared to office buildings.

TABLE 10. Distribution on building types

Residential (R)	11
Office (O)	7
Mixed use (predominantly office/residential) (M)	0
Other (please describe below) (OT)	0

The 18 Danish building projects are distributed on project stages as shown in Table 11. The table shows that the test projects tend to be in either the design stage or the completion and handover stage. It should be noted that the projects in the occupation stage is not reporting on actual figures yet, but refers to simulations and calculations done during the design and construction stages.

TABLE 11. Distribution on project stages

Design stage (Des)	5
Construction (Con)	3
Completion and handover (Hand)	6
Occupation (Occ)	4

Table 12 shows the distribution of test projects on project type (existing building or new building) versus building type (residential and office).

TABLE 12. Distribution on project type versus building type

	Residential	Office
Existing building	3	1
New building	8	6

The vast majority of involved respondents cover the typical project participants like architects and engineers (including structural and HVAC engineers) supplemented in most projects by energy consultants, sustainability consultants and DGNB consultants, while other project participants like the private non-profit foundation Realdania, contractor, facility manager and public affairs manager have also contributed in a very limited number of cases.

The filling of the survey could be done either as a team or individually. Table 13 shows the distribution of responses of the 18 Danish building projects. The table shows that responses are distributed evenly between team responses and individual responses.

TABLE 13. Distribution on responses

Team response	8
Individual response	10

The stakeholders participating in the test projects overwhelmingly include building design and construction professionals involved in the building project, while public authorities have not participated at all and private investors and owners have only participated in one test project (Table 14).

TABLE 14. Stakeholders involved in test

Public authorities involved in the test, including as clients and investors in the building	0
Private investors and owners of the building asset	1
Building design and construction professionals involved in the building project	17

The 18 Danish building projects are distributed on Level(s) reporting requirements, as shown in Table 15. Please note that not all projects have tested all reporting requirements; that some projects test one reporting requirement at one level and another reporting requirement at another level; and that a few projects test the same reporting requirements at more than one level.

TABLE 15. Distribution on Level(s) reporting requirements

	Level 1	Level 2	Level 3	N/A
The Level(s) test minimum reporting requirements				
1.1 Use stage energy consumption	11	5	2	0
2.3 Construction and demolition waste and materials	12	4	1	1
3.1 Use stage water consumption	9	7	1	1
4.1 Indoor air quality	12	1	5	0
4.2 Time out of thermal comfort range	9	4	5	0
Recommended in addition to the Level(s) test minimum reporting requirements				
1.2 Life cycle Global Warming Potential (GWP)	3	4	1	10
2.1 Life cycle tool: Building Bill of Materials (BoM)	1	2	1	14
The Level(s) test optional additional reporting				
2.2 Life cycle tool: scenario 1 - Building and elemental service life planning	2	2	0	14
2.2 Life cycle tool: scenario 2 - Design for adaptability and refurbishment	4	2	0	12
2.2 Life cycle tool: scenario 3 - Design for deconstruction, reuse and recycling	5	2	0	11
2.4 Life cycle tool: Cradle to cradle Life Cycle Assessment (LCA)	3	3	0	12
5.1 Life cycle tool: scenario 1 – Protection of occupier health and thermal comfort	4	0	2	12
6.1 Life Cycle Cost (LCC)	3	1	6	8
6.2 Value creation and risk factors	4	0	0	14

The table shows two major tendencies. First, the test projects tend to focus on the minimum reporting requirements. Second, the test projects tend to focus on Level 1. In addition, it is worth noticing that Level 2 and Level 3 was also to some extent applied concerning the minimum reporting requirements, especially for energy consumption and time out of thermal comfort range. It should be noted that it was demanded by the EU to test the minimum reporting requirements and at least one extra requirement.

Concerning the recommended additional requirements, the two parameters have only been tested in a few projects. It should be noted though that calculation of Life Cycle Global Warming Potential is part of the Danish de facto national standard tool LCAbyg for LCA calculations. Hence, the full number is higher.

With regard to the optional reporting requirements, most of the tools are applied only in a few test projects and only on Level 1 and 2. The most noticeable exception is 6.1 Life Cycle Cost, which was applied in more than half of the test projects, very likely due to existence of

LCCbyg, a national de facto standard tool for LCC calculations and the requirement to use it in DGNB certified projects.

2.2 Level(s) assessment reporting tool

The Level(s) assessment reporting tool beta-version 1.1 is divided into four parts:

- An introduction describing the Level(s) framework of reporting at different project stages and different levels of performance assessment.
- Assessment checklist in 7 steps.
- Description of the building project.
- Input following various indicators and tools versus four different stages.

Appendix A includes an overview of 7 steps in the assessment checklist, an overview of the descriptive information on project contact and base registration of the building along with several parameters, and an example of the input procedures in the spreadsheet in more detail based on Indicator 1.1 Use stage energy performance.

The performance assessment in the relevant project stages also includes a reliability rating. The system for reliability ratings uses a four-step ladder of high, medium, low and rating aspect not addressed. The ratings cover three different aspects (for further details, consult Appendix B).

- Technical reliability related to the representativeness of e.g. data input (specific for each indicator and tool).
- Professional capabilities of the team conducting the assessment.
- Independent verification of third-party.

This evaluation report does not contain any of the performance assessments of the building projects. Although the intention from the outset was to generate benchmarks based on the assessment, it turned out that the number of responses for each parameter was very small. Indeed, the benchmarks would be based on figures from only one or just a few buildings, which would make them less reliable. Further, it would be difficult if not outright impossible to maintain confidentiality.

2.3 Level(s) test survey

Along with the results from the test building projects, the European Commission was also interested in the experience of testers using Level(s). Hence, EU JRC developed an extensive online survey to be filled in by each test building project. The Commission wished to obtain feedback on three key aspects of the testing of Level(s):

- How useful was Level(s) for assessing the building's performance?
- How did the design of Level(s) support the process of making the assessment?
- How user-friendly were the selected indicators and life cycle tools, together with their supporting guidance?

The main elements of the test survey were as follows:

- Details of the test building projects.
- Expectations and previous experience.
- How level(s) is designed.
- The value of Level(s) to key stakeholders.
- Using the test indicators and life cycle tools:

- Minimum requirements.
- Recommended in addition to the minimum scope.
- Optional additional reporting.

EU JRC recommended that the questions were reviewed with all those in the project team who was involved in the test in order to capture the experience and feedback of the team as a whole. As the survey took place online, it was recommended to save the survey frequently as the participants completed it, so as not to lose any work. In addition, the EU JRC supplied an off-line version in printable format as a pdf file.

Since both the online version and the printable version of the survey hampered the collection and processing of responses, the Danish evaluation team decided to convert the survey to an MS Excel spreadsheet following the exact same structure, questions etc. as in the test survey. This spreadsheet allowed the test building projects to gather and access responses as pleased and at the same time, allowing the national evaluation team to process and analyse the test results in an easy manner.

2.4 National evaluation process

The national evaluation process included four workshops with participants from the test projects. The themes of the four workshops are listed below (more details on the time, place, purpose and agenda of each workshop can be found in Appendix B):

- Workshop 1: Kick-off.
- Workshop 2: How to report macro objectives 1-6.
- Workshop 3: Lessons learned and reflections.
- Workshop 4: Challenges related to renovation projects

In addition to the four workshops, the participants in the evaluation have used Microsoft Teams as a collaboration platform. The platform was set up with a general channel, separate channels for each workshop, and individual channels for each of the macro objectives in Level(s). The actual use of the collaboration platform has, however, been rather modest.

Finally, two national conferences were scheduled after the finalisation of this evaluation report. The two national conferences presented the results of the evaluation to the Danish building industry, policymakers and researchers. The conferences provided input to the continued debate on if and how Level(s) could and should be adopted in the Danish building industry.

3

EXPECTATIONS AND PREVIOUS EXPERIENCE

3 EXPECTATIONS AND PREVIOUS EXPERIENCE

3.1 Expectations

The participants of the test projects reported their expectations and previous experience with sustainable performance assessment. The responses on their general expectations that motivated the use of Level(s) are summarised in Table 16 below:

TABLE 16. Expectations when joining the test phase

Expectations	Number of responses
That it would provide information to establish objectives and targets for the sustainability of projects	10
That it would provide information to measure whether sustainability objectives and targets have been met	13
That it would provide information about the benefits of more sustainable buildings to clients/users	7
That it would provide information to avoid future risks (e.g. high carbon tax, high costs of renovation, low occupant satisfaction and therefore high property void rates)	2
The possibility to compare a Level(s) assessment with assessments made using existing schemes (e.g.DGNB, HQE, BREEAM etc.) or recent or forthcoming national regulation (e.g. in the Netherlands or France).	16
That it would provide information to support benchmarking and comparisons of the performance of different buildings	9
Other (please specify)	0

Multiple responses are possible.

The two highest-scoring expectations are:

- The possibility to compare a Level(s) assessment with assessments made using existing schemes (e.g. DGNB, HQE, BREEAM etc.) or recent or forthcoming national regulation (e.g. in the Netherlands or France).
- That it would provide information to measure whether sustainability objectives and targets have been met.

Other expectations are included in the following quotes from the respondents:

- I would like to get to know Level(s) and to actually work with it. Also, by joining the test phase I have the possibility to give feedback and perhaps have influence on the final Level(s) handbook.
- Learning about Level(s) and experience different approaches from the different countries.
- Creating a Danish touch on the test phase and evaluation.
- We are excited about whether the system can handle an existing building as our building. In the future progress we would like to see how the building is evaluated against Level(s).
- A chance to get to know Level(s) and a chance to participate in the development of Level(s).

- We expected a tool that would be able to test the sustainability of the building in various degrees, and be able to say to which extent certain goals had been met.
- My expectation is that there will be some difficulty in using Level(s) for renovation projects, and that a DGNB certification facilitates the work / execution considerably.
- Since I have already done a test of Level(s), I have some insight into what Level(s) can or cannot. Thus, my expectations are more a question of how much of Level(s) can be used today to renovations and how. Furthermore, a question of how much more is required, or possibly less to perform an assessment in Level(s) about renovation. I do not think there are as many demands for renovation projects as for new buildings - especially not within sustainability (unless you carry out a DGNB certification). Thus, I will assume that Level(s) can contribute to a discussion on sustainability in the project, ask questions about several studies, etc. and that way get more sustainability included in the projects.
- We want to be at the forefront of the industry and are curious to understand how Level(s) may influence the current market of sustainable building certifications.

3.2 Previous experience

Table 17 below summarises the test team's overall previous experience in making environmental or sustainability performance assessments of buildings. As is evident from the table, the vast majority of test participants consider themselves to be highly experienced.

TABLE 17. Previous experience

Previous experience	Number of responses
No previous experience	1
Limited previous experience (e.g. minimum energy/Energy Performance Certificate (EPC) requirements)	1
Some previous experience (e.g. simplified building simulations, comparisons of building materials based on Environmental Product Declarations (EPDs), water use estimates)	3
Extensive previous experience (e.g. dynamic building simulations, LCA assessments, building certification scheme assessments)	13

The experience by the test teams of making environmental or sustainability performance assessments includes a wide range of tools and schemes:

- Building simulations of various kinds like IES-VE (developed by IES) and BSim (developed by SBi).
- Use of national Danish tools like LCAbyg (life cycle assessment), LCCbyg (life cycle costing) and Be18 (energy simulation), all developed by SBi.
- Certifications like DGNB-DK (extensive experience due to Danish adaptation of the German scheme), BREEAM (including in-use and the Norwegian adaptation BREEAM-NOR), LEED, GreenStar, GRESB, Ecolabel, WELL and CEEQUAL.
- Design approaches like Active House, Miljöbyggnad and Sustainability Management.
- Additional LCA tools like Klimagassregnskab.no (StatsBygg).
- Additional energy simulation tools like Whole Building Energy Simulations.

In the event that the test project followed the minimum scope, the test participants provided the following statements regarding what would have encouraged additional testing of optional indicators and life cycle tools. The statements fall into two main groups:

- Purpose and user-friendliness of Level(s).
- Scope, time and resource issues related to the test projects.

The statements regarding the purpose and user-friendliness of Level(s) – in particular the manual and spreadsheet – include:

- A more simple structure and less reading material. It would have been great to have had more elaborate examples, perhaps on an actual case.
- The manual should be easier to understand. It is hard to understand the meaning of the indicators, which is written in a very technical manner.
- The purpose of Level(s) is not clear, and it makes it harder to understand the meaning of Level(s).
- To emphasize the use of Level(s) and why it should be used, the added value to the project should be clearer. Where is Level(s) strong to use in the process?
- Emphasize the financial benefits, branding and value engineering.
- Insight in the tool – a more complete evaluation of the tested project.
- More knowledge of life cycle assessments and better explanation in the tool. The manual is difficult to understand, and the tool contains errors that confuse and complicates the use of it.
- That there was an easier approach to Level(s), understanding of the individual macro objectives and that there were requirements in terms of levels etc. (benchmarks). There is also a possibility for more general input to larger perspectives in the various macro objectives.

The statements regarding scope, time and resource issues related to the test project include:

- Scope decided on the base of customer demands and project relevance.
- We would have liked to do further testing but would have needed more time and specific skills to do so.
- Cover costs for the time used for testing.
- Available time and resources.
- I would love to do the full test for a customer if I was paid for it. Now it is an internal project in my company, and we don't have the funding to do the full test.
- The project was at an earlier state than expected. Therefore the design team did not have sufficient data to work more thoroughly with Level(s).
- More time, more explicit information, group-work like for the minimum reporting macro objective (MO) requirements (part of the Danish national test).
- A simple tool that provides a better sustainable "score" and makes you able to make the right decisions and provide information about the benefits of more sustainable buildings to clients/users.

4

HOW LEVEL(S) IS DESIGNED

4 HOW LEVEL(S) IS DESIGNED

The participants were asked to evaluate the design of Level(s) and how it helped them improve the sustainability of their projects. Table 22 summaries the answers related to the design of Level(s). The participants indicated in the questionnaire that the current design of Level(s) provides no or limited support for the work on buildings sustainability in their projects in relation to setting sustainability objectives, obtaining practical information on the building's sustainability performance or focus on measuring the current performance of the building use.

TABLE 18. Assessment of how Level(s) is designed

	Not at all	Limited extent	Moderate extent	Great extent	Very great extent	Not relevant to this test
To what extent did Level(s) help you and your team to obtain practical information on the sustainability performance of the test building?	4	9	2	1		
To what extent did Level(s) help you and your team to identify design performance improvement measures?	4	6	2	1		3
To what extent did Level(s) help you and your team to set sustainability objectives and targets for the performance of the test building?	7	4	3	1		1
If you used Level(s) already in the planning stage, to what extent is the data collected for Level(s) the same as that needed for building permits?		2	1			12
To what extent did Level(s) help in focussing on the monitoring of the actual performance of an occupied building?	5	3	3			5

The following additional comments were given by the participants in the questionnaire:

- The team is using DGNB in this project, and we haven´t used Levels as a design guide.
- I do not think Level(s) gives an overview of the sustainability in a project.
- The idea of a simple reporting tool with few inputs is good. The possibility to add information even better. However, the purpose is murky.
- With low information, is it still possible to be a part of Level(s)?
- Level(s) seems to work alone with buildings in the design stage.

The participants were asked to what extent they found it useful to be able to work with the three distinct levels. As Table 19 shows, most of the participants answered useful in moderate extent (8 out of 17), while 6 out of 17 found it not useful or only useful in limited extent and 3 out of 17 useful in great extent.

TABLE 19. Assessment of usefulness of the three levels

	Not at all	Limited extent	Moderate extent	Great extent	Very great extent
Based on the Levels at which you chose to test, to what extent did the test team find the option to work at the three distinct levels to be useful?	2	4	8	3	

The following additional comments were given by the participants in the questionnaire:

- We only tested on a single level.
- To work with three levels could be useful, but the purpose and the definition of the respective level was not very useful. The input in level 2 and 3 was in this test not very relevant or possible to implement.
- I think the idea is good, but as mentioned before, the content is too advanced, even in level 1.
- Gives the possibility to choose the level which best represent the knowledge at the current building stage and/or act as focus for the work with the building.
- We did not find the three levels useful.
- The three different levels differs only on the quality of data have been collected. This is useful in order to understand to what extent the assessment is credible. However, it is not clear in the manual whether this is crucial for the assessment of the building.
- Level 1 is only useful if it is used in the very phase before any decisions are made. It is important to stress that this is a tool meant for supporting decision making and not for measuring what have already been decided.
- It was initially very difficult to understand and to know how to use Level 2 and Level 3 in a proper way. In this specific project the difficulty was mainly due to this project/building being finished/completed – so the possibility of comparing and optimising was impossible. Furthermore, it was also difficult to imagine how to use Level 2 and Level 3.
- For some indicators it was difficult to specifically know where Level 1 and 2 were diverse e.g. how to conduct the "extra" reporting.
- The three levels seemed to have different interpretations in the different indicators, which complicated the understanding and therefore implementing the three levels. Usually the three levels are meant to be: assessment- benchmarking-optimization but often the higher levels (level 2 and 3) included higher levels of detail in the original assessment, perhaps for more detailed assessments, which complicated their use. Additionally, since there are still no available standard buildings suggested for each case, it is very challenging and time demanding to find another example in order to perform the benchmarking and then suggest optimization measured. Additionally, in the use stage this can be achieved by retrofitting and renovating, which is not emphasized at all in levels, giving the general feeling that the guidance is only intended for building under design. In other words: the benchmarking purpose rather than numerical evaluation was difficult to get used too. Nevertheless not a bad method to try to work with.
- Other projects did also have troubles with understanding how to compare: 'who should one compare one’s project with', and 'where should the compared result be written'. During the participation, the participants got more experience and came to the conclusion that Level 2 reminded of Level 1 but with fixed parameters, and that the variation was up to the participants themselves to decide.

5

THE VALUE OF LEVEL(S) TO KEY STAKEHOLDERS

5 THE VALUE OF LEVEL(S) TO KEY STAKEHOLDERS

5.1 The value of Level(s) to key stakeholders

The participants were asked to what extent Level(s) provided enough information to decide with their clients which sustainability aspects should be addressed in the test building.

TABLE 20. Satisfaction with amount of information

	Not at all	Limited extent	Moderate extent	Great extent	Very great extent
Taking into account the minimum scope for a test, to what extent did Level(s) provide enough information to decide with your client which sustainability aspects should be addressed in the test building?	7	4	3	2	

The respondents provided the following additional comments and recommendations:

- Would rather use a scheme as DGNB to decide which aspects to address, as the system is known in Denmark and it has a clearer structure to relate to a client's triple bottom line. Furthermore conditions in DGNB allows for benchmarking.
- The best thing I can say about Levels is that it puts up a framework with important subjects to consider in designing a sustainable building. However, it is far too complex in its present form. And it is a comprehensive task to understand the system and define what data to use and whether the outcome is more "sustainable".
- In the test building this is not relevant since it is tested in the "implementation phase" (as built). However, I imagine Level(s) could function as a decision tool in the design phase.
- However, if Level(s) is trimmed and streamlined it could be of great use and value to a sustainable Europe. The idea behind it is great; it adds something new compared to DGNB, BREEAM etc. Benchmarking on an "absolute sustainability" on a national and international level could stimulate sustainable building in EU.
- I was missing a benchmark for the data input. If a project isn't evaluated om several levels or stages and so on, you have nothing to compare with. The assessment influence on market and reliability rating is a positive new input, I haven't worked with before. But I am still missing some sort of level for the input data.
- My guess would be that it would be good to put focus on different sustainability aspects, but very difficult to make a client understand the aspects completely.
- The indicators tested for this project are rather standard in designing, so Level(s) does not add more useful information.
- We did not use Level(s) externally or to optimize our building, because this has already been a part of the DGNB-certification of this building.
- We did not find it useful.
- The reporting tool doesn't provide any results. Therefore it cannot be used to take decisions. On the other hand the mandatory indicators required from Level(s) can give an overview of a building's sustainability. However, the results should be assessed and evaluated separately by the involved professionals.

- If the building had not undergone a certification in advance, Level(s) would have been a fine tool for assessing the sustainability measures to be incorporated into the project and to what extent. However, it is important that the tool is used very early in the process, so that you do not lose the chance of incorporating sustainable measures.
- Not relevant due to existing building project.
- As Level(s) reporting was conducted after the design phase, this was not the case. We do however see the potential for it.
- This was not in the context of the specific assessment, since we are the owner of the building.
- It is possible to add more scenarios, but I miss for example a diagram to compare scenarios. It would make it easier to understand and communicate technical information.

The participants were asked to what extent Level(s) provided meaningful information to support design and specification decisions.

TABLE 21. Assessment of how Level(s) is designed

	Not at all	Limited extent	Moderate extent	Great extent	Very great extent	Not relevant to this test
To what extent did Level(s) provide meaningful information to support design and specification decisions?	6	4	1	1	0	4

The respondents provided the following additional comments and recommendations:

- Considering Level(s) as a reporting tool it does not provide much information apart from topics that could be considered in the project. No method and conditions are presented and the system therefore lacks benchmarking against other buildings or a baseline to actually measure what was good and what was not.
- Tools with defined targets will be useful.
- In the test building this is not relevant since it is tested in the "implementation phase" (as built). However, I imagine Level(s) could function as a decision tool in the design phase.
- A benchmark is missing. There is nothing to hold the results / input up against which is useless in order to actually use the input
- In our test Levels was used after the design process, but if it was to be used in the design process, i would have liked more extensive guidance notes. It is very inaccessible and technical. Some more simple tools to support the design phase would be helpful, otherwise it takes a lot of resources to carry out. It is difficult to use the obtained values from the calculations, when you do not have something to measure against.
- The indicators tested for this project are rather standard in designing, so Level(s) does not add more useful information
- Level(s) lacks the possibility to benchmark the results. Is this GWP-number good? Is it bad?
- We did not find it useful.
- As mentioned the mandatory indicators required by Level(s) can provide an overview of a building’s sustainability. However, they cannot be assessed by Level(s) reporting tool. The tool gives no results thus it can not be used for taking any decision.
- Some kind of benchmark is missing. It could be useful to have something to compare your results with. A possibility to assess whether the solutions are sustainable or not.

- A missed feature in Level(s) is the possibility to make benchmarking or comparison with ones results and predefined results/standard results. Thereby it could be possible to get a feeling of how sustainable ones solutions/building is – or is not.
- The indicators can be used to set requirements for the design phase but also for the occupation/use phase of the building, which can add value for the users.
- The building is in use
- There are several sustainability systems (DGNB, LEED, BREEAM, HQE etc.) that are significantly further ahead in terms of sustainability. Level(s) do not encourage variant analysis, as you do not know if the value is high or low.
- It is difficult to understand the technical input without a reference value or something to compare with.

6

USING THE TEST INDICATORS AND LIFE CYCLE TOOLS

6 USING THE TEST INDICATORS AND LIFE CYCLE TOOLS

This chapter includes the answers from the Level(s) test survey related to the indicators and life cycle tools. The lessons learned from using the 9 test indicators and 5 life cycle tools are organised according to the three levels of ambitions:

- Minimum requirements:
  - Indicator 1.1 Use stage energy consumption:
  - Indicator 2.3: Construction and demolition waste and materials.
  - Indicator 3.1 Use stage water consumption.
  - Indicator 4.1: Indoor air quality.
  - Indicator 4.2: Time out of thermal range.
- Recommended in addition to minimum scope:
  - Indicator 1.2: Life cycle Global Warming Potential (GWP).
  - Indicator 2.1: Building Bill of Materials (BoM).
- Optional additional reporting:
  - Life cycle tool 2.2: scenario 1 – Building and elemental service life planning.
  - Life cycle tool 2.2: scenario 2 – Design and adaptability and refurbishment.
  - Life cycle tool 2.2: scenario 3 – Design for deconstruction, reuse and recycling.
  - Life cycle tool 2.4: Cradle to cradle Life Cycle Assessment (LCA).
  - Life cycle tool 5.1: scenario 1 – Protection of occupier health and thermal comfort.
  - Life Cycle Cost (LCC).
  - Indicator 6.2: Value creation and risk factors.

6.1 Minimum requirements

6.1.1 Indicator 1.1 Use stage energy consumption

The indicator focuses on the operational energy use in the building, which is related to the obligatory calculations on building energy consumption in the building code.

TABLE 22. Distribution on Level(s) reporting requirements

	Level 1	Level 2	Level 3
1.1 Use stage energy consumption	12	5	3

Twelve projects tested this indicator on Level 1, five on Level 2 and three on Level 3. In total, there are therefore 20 reports on this indicator, which means that some projects tested the indicator on multiple levels.

Applicability and ease of use

This section of the survey focuses on energy consumption in the use stage. Based on their experience with the indicator, the respondents were asked to evaluate whether the indicator was logical and easy to use. Specifically, the participants responded to the following question:

> *"To what extent was the indicator or life cycle tool easy and logical to use?"*

The question above consisted of seven sub-questions, which the participants were asked to respond to. Their responses are summarised in the following table.

TABLE 23. Ease of use – indicator for use stage energy consumption

Q1. To what extent was the indicator or life cycle tool easy and logical to use?	Not at all	Limited extent	Moderate extent	Great extent	Very great extent	Not relevant to this test
1.1 The guidance for making a common performance assessment provided in the JRC Level(s) documentation	1	4	9	2	1	0
1.2 The calculation method(s) and standards that are specified should be used	0	4	7	3	1	2
1.3 The unit of measurement that is specified should be used	0	2	3	6	6	0
1.4 The reporting format that is provided in the documentation	0	6	6	2	2	0
1.5 The suggested calculation tools and reference data sources	0	6	6	2	1	1
1.6 If used, the Level 2 rules for comparative reporting	1	4	2	1	0	5
1.7 If used, the Level 3 aspects and guidance notes	0	3	1	1	0	7

Note. Projects reported on this indicator: 18/18 - Responses from 17/18.

Table 23 illustrates a general satisfaction with the unit chosen for measurements among the participants and that they found the guidance for making the assessment and the calculation methods and standards easy and logical to use in more or less moderate extent. The participants found the reporting format provided and the calculation tools and reference data sources suggested in limited or moderate extent easy and logical to use.

Furthermore, the requirements for Level 2 and Level 3 are considered irrelevant by about half of the respondents reflecting that few case buildings have applied more than Level 1 in the test. However, for those who answered, the rules for Level 2 and Level 3 are evaluated as easy and logical to use in a limited extent.

The participants were asked to reflect on to what extent the indicator helped them to make a comparison of different building designs. Their responses are shown in Table 24 below.

TABLE 24. Supporting comparison of alternative design options

	Not at all	Limited extent	Moderate extent	Great extent	Very great extent	Not sure
Q2. If comparisons were made of different buildin g design options, to what extent did the indicator or life cycle tool help to do this?	1	0	1	0	1	7

Note. Responses from 10/18.

Subsequently, the participants were asked to reflect, to what extent whether they encountered any issues in obtaining the results for the indicator or life cycle tool. Their responses are summarised in Table 25.

TABLE 25. Extent of problems obtaining results

	Not at all	Limited extent	Moderate extent	Great extent	Very great extent
Q3. To what extent did you encounter any problems in obtaining a result for the indicator or life cycle tool?	5	6	4	1	0

Note. Responses: 16/18

The results summarized in Table 25 above, shows that few people encountered problems in obtaining a result for the indicator. The type of problems mentioned were:

- It is unclear, to what extent the national calculation tool Be18 provides the exact information that Level(s) require.
- We were not able to specify the mix of renewable and non-renewable energy.
- We had some trouble finding out what to define as use stage energy demand / use stage delivered energy demand.
- The main problem was to get specific values for delivered energy demand. The values weren't estimated during design phase thus the values could possibly be obtained from bills by facility management. However, due to limited time no specific data for all categories (ventilation, hot water etc.) have been added. Moreover, the tool doesn’t provide any result in order to make any assessment or decision.
- It was difficult to choose the phase in the 'Input sheet', because there were no assessment sub-type called 'Calculated' if choosing 'Operation and occupation stage'. Therefore 'Completion and handover stage' was selected, even though the real project stage is operation.
- But it was difficult to figure out what data should be reported in the excel-sheet (assessment reporting tool).The reporting tool needs more explanation.
- It can be difficult for non-energy-experts and non-LCA-experts to read the energy numbers needed for this reporting. General description and guidance is needed for the EU Tool reporting headings e.g. "Expoerted energy generated" as the wording may vary from country to country.

With regard to renovation cases, the participants in the national evaluation workshops added the following comments:

- For Sorgenfrivang II (a renovation project), a DGNB pre-certification was carried out and at the same time a lot of work was done on sustainability of the project through various analyzes. Because the project was rather large, there were conducted studies on energy consumption. Thus, it was possible to find the information for this M.O.
- It does not seem a renovation project will have any difficulties reporting on this credit as deep retrofits will have to meet the current regulation and will thus need these energy simulations conducted at least in a Danish context. Should the renovation however not meet the current energy requirements, this credit will help push for energy simulations and variation comparison

Accessibility to data, tools and standards

The respondents were asked to specify whether they had used other tools, datasets or references when making the assessments. The responses are summarized as in the table below.

TABLE 26. Use of other references, datasets or tools

	Yes	No
Q4. When making the assessment, were there any other specific references, datasets or tools you had used on other building assessments that proved useful?	7	8

Note. Responses: 15/18

In supplementary comments, the respondents referred to the following tools and methods that were useful:

- National evaluation method, DGNB evaluation method.
- National tools such as Be10, Be18, BSiM, IDAICE and LCAbyg.

The table below summarises their access to the required results from other previous assessments of the building.

TABLE 27. Access to previous assessments

	Not at all	Limited extent	Moderate extent	Great extent	Very great extent
Q5. To what extent did you already have access to the required results from other assessments of the building?	0	0	4	8	5

Note. Responses 17/18

The participants identified the following sources of results, which were either available already or diverged from Level(s). The 18 different comments were grouped into two main groups of answerers:

- Danish regulations result from the national calculation tool (Be10, Be15 or Be18) to calculate the operational energy use/demand in buildings
- DGNB assessment, and LCAbyg tool use for DGNB assessment

However, two projects reported that they had no sources of results already available

The participants were asked to respond to how available standards, tools or data were. The following Table 28 summarises the responses received.

TABLE 28. Availability of standards, data and/or tools

Q6.If you had to obtain the standards, data and/or tools in order to make the Level(s) assessment, how readily available were they?						
Please answer for each of the following aspects	Not possible to obtain	Difficult to obtain	Some effort to obtain	Easy to obtain	Already had them	*Not relevant to this test building*
6.1 The technical standards used	0	0	0	0	0	3
6.2 The databases used	0	0	0	0	0	5
6.3 Calculation and modelling tools	0	0	0	0	0	2

The respondents did not answer on the possibility to access standards, data and tools, and only a few answered that this was not relevant for this test building.
The following Table 29 focuses on the cost of the standards, tools or data. The vast majority of the respondents answer that the cost would not be a barrier. However, few answered that it would be the main barrier, and mainly for the tools.

TABLE 29. Cost as barrier

Q7. If you had to purchase the standards, data and/or tools, to what extent was their cost a barrier to using them?			
Please answer for each of the following aspects	Not at all	One of the factors	The main factor
7.1 The technical standards used	6	0	2
7.2 The databases used	7	0	1
7.3 Calculation and modelling tools	7	0	4

Note. Responses 11/18

Competences

The participants were asked to describe the previous experience of the test team with a similar indicator or life cycle tools. Their answers are summarised in Table 30 below.

TABLE 30. Previous experience with similar indicators or tools

Q8.	No previous experience	Limited previous experience	Some previous experience	Extensive previous experience
How would you describe the previous experience of the test team with similar indicators or life cycle tools?	1	1	4	11

Note. Responses 17/18

The number of responses summarised in the table above illustrates that the main part of the respondents has extensive previous experience with the indicator. Only two have no or limited previous experience with this indicator.

Taking their previous experience into account, the respondents were asked to respond to the question about whether the use of the indicator required additional training and support. Their responses are summarised in the following Table 31.

TABLE 31. Need for additional training

Q9.1	Not at all	Limited extent	Moderate extent	Great extent	Very great extent
Based on the previous experience of the test team, to what extent did using this indicator or life cycle tool require additional training and support?	9	2	4	1	1

Note. Responses 17/18

Nine out of 17 answered that they would not need additional training, and only two indicated that they in great or very great extent would need additional training and support to work with this indicator.

Furthermore, the respondents were asked to elaborate on the type of training, which is required in order to use the indicator or life cycle tool as intended. Their responses are summarised in Table 32 below.

TABLE 32. Areas of additional training

Q9.2	Knowledge of standards or methods	Calculation or modelling tool software use	Access to and handling of data sets	Other (please specify)
If additional training and support was required, please identify the main areas where it was necessary	3	1	5	3

Note. Responses 12/18

According to the table above the access to and handling of datasets was identified as the main area, but also knowledge of standards or methods. The respondents further identified the type of training and/or support that was needed:

- In order to full fill all the required data use of Energy simulation software is necessary. In addition an explanation on the methods in order to calculate the amount of energy used is also needed.
- In general, it is important to have a cross-disciplinary understanding or work closely together across disciplines to be able to report this credit.
- It was hard to understand the manual.
- Operation manager for the construction project and for the finished construction

Table 33 gives an overview of the estimated costs in man days fulfilling the requirement for this particular indicator or tool. Oone-third of the respondents have not replied to this question. From the ones answering the question, 8/12 have spent a day or less, and a smaller group (4/12) has spent 2 or more days. It is not clear whether the last group of answers is effectively covering the entire test or just this indicator tool.

TABLE 33. Estimated time consumption in man days

Q10.1 If possible please provide an estimate of the cost and/or time that were required to use this indicator or tool.	No response	0.1	0.25	0.5	1	2	3	7	8
	6	1	2	2	3	1	1	1	1

Table 34 gives an overview of the estimated costs in Euros for fulfilling the requirements for the particular indicator or tool. More than half of the respondents have not answered the question. The responses over a very wide range all the way from EUR40 to EUR5,000.

TABLE 34. Estimated cost in Euros

Q10.2 If possible please provide an estimate of the cost and/or time that were required to use this indicator or tool.	No response	20	230	800	1,000	1,300	1,930	2,100	5,000
	10	1	1	1	1	1	1	1	1

Suggestions for improvement

The participants were asked to make suggestions for improvements to the indicator that would make it easier to use. The following suggestions were received:

- It is difficult to follow the resemblance between the tool and the guidance in report 3.
- Sometimes the indicators are mentioned as Macro objectives (M.O) and sometimes as indicators. It makes it difficult to understand.
- There are a lot of different names: indicators, checklist, part, objectives, level, rating. It becomes very confusing.
- There are many different standards mentioned – all is not examined, because of the time use it would demand. Is all relevant for example, the Danish standards? Or are they similar to some of the Danish standards?
- The manual/report is difficult to understand and difficult to follow.
  The part regarding renewable energy is uncertain if understood correctly. How should it be documented in the schemes correctly? 1.1.2 is for delivered energy demand – but what is the meaning of 1.1.1? And what is the difference?
- Also the energy demand for the renewable energy is to be documented for a specific energy use – but in most cases it isn't possible to define the direct use of the renewable energy. Should you divide it equally on all possible energy uses?
- Valuation cratering/sub-criterion and influence on the valuation or rating in Checklist 2 is not understood.
- The table was difficult to understand/or made from a different logic meaning that the table should have been better explained .
- National standard for Level(s).
- Level(s) need's to be more simple. Manual is way too technical and should be in less pages.
- There should be some benchmarks for each Levels.
- The reporting scheme for energy consumption at use stage requires some specific knowledge on relevant EN ISO standards as well as on how to perform calculations. Hence, it might be time consuming for someone who is not familiar with such evaluation to full fill the report. A suggestion could be to provide more detailed and simple explained guidance on how to use the standards and how to perform the calculation methods to get the desired outcome. A feedback on the performance and validity of the assessment would be useful as well
- This is a very simple tool. More details ought to be taken into account.

- Make several examples of how to report the results correct in the spreadsheet (according to project phase and building type).
- Similar units e.g. kWh/MJ.
- OK simple to fill in the results. Existing performance assessments can be used for reporting, eg. BE18 in Denmark.
- Calculation of energy is a national standard. It is here the challenge also appears - identifying EN standards and national standards.
- It would ease the input if there were decided upon EPB-tool, steady state, quasi-steady or dynamic
- I have not given feed-back on the databases or modelling tools suggested, because I didn't see the suggestions in the manual. I could only find information on standards.
- It is very difficult to figure out, where to put the "produced energy" in the assessment reporting tool. I do not understand what the difference between "1.1.1 Use stage primary energy demand" and " 1.1.2 Use stage delivered energy demand" is. What am I supposed to write in the different cells? And when we have some produced energy on the building, do I need to put it under a category, such as e.g. "Ventilation"? I don't know how the energy is used, I just know that it is electrical energy produced.
- In Denmark does architects not know all the national standards the engineers are using. It’s a challenge for us.
- Better explanation of the tool, and consideration of whether the 3 levels make sense in all phases and for all projects. Possibly there should be a priority or distribution of M.O in relation to the size of the renovation case. If a comparison project, or benchmarks, was included, then the level of sustainability could be better assessed in the early stages - if we do not want to continue with optimization in relation to sustainability.

The value of using Level 2 and Level 3

For this indicator, five projects reported on Level 2 and three projects on Level 3.

TABLE 35. The value of using Level 2

	Not at all	Limited extent	Moderate extent	Great extent	Very great extent	Not sure
Q12.1 To what extent did Level 2 prove to be useful in making comparisons between buildings?	1	4	0	1	1	1

Note. Responses: 8/18 – five projects reported on Level 2

If the value of using Level 2 was moderate or higher, the participants were asked to reflect on how its use influenced the results. Although only two projects reported “moderate or higher”, several comments were received. These are listed here below:

- According to Danish regulation a comparative analysis is mandatory, so it's used to see whether the project complies with the Danish building code.
- Is was impossible to be used for us, since our building was completed and taking in to use several years ago. That being said, reading about it and imaging how to use it seemed great and very useful. Especially since the fixed values were very specific to carry on with.
- To make it national comparable same standards and climate data/methodology should be used.
- It would be nice to have a more visual output, for example diagrams or similar. Then it would be easier to compare the scenarios.

- To make it national comparable same standards and climate data/methodology should be used. This is what Level 2 ask for - ensuring the scope for the comparison is the same. But there is no place to report on the comparison, which seem strange.
- Did not make comparisons.

TABLE 36. The value of using Level 3

	Not at all	Limited extent	Moderate extent	Great extent	Very great extent	Not sure
Q13.2 To what extent did Level 3 prove useful in obt aining more precise and reliable results?	0	1	0	1	0	4

Note. Responses 5/18 – 3 projects reported on Level 3

Very few answered to this question, but also only three projects reported on Level 3 for this indicator. If the value of using Level 3 was moderate or higher, the participants were asked to reflect on how its use influenced the results. Only one project reported “great extent”, but the following comments were received:

- Level 3 was used on 4 different facade designs. The chosen facade was among others based on energy consumption.
- Requires data from the buildings occupied stage, which was not retrieved.
- Not really used.
- Did not make comparisons.

Summary

The number of responses for this indicator was high since the indicator is mandatory. There was a general satisfaction with how easy and logical the unit chosen for the measurements among the participants (great to very great extent). They found the guidance for making the assessment and the calculation methods and standards easy and logical to use in more or less moderate extent. The participants found the reporting format provided and the calculation tools and reference data sources suggested logical and easy to use in limited or moderate extent. The participants were not particularly keen on the rules provide for comparative reporting on Level 2 and the aspects and guidance notes for Level 3.

The participants did not encounter problems obtaining the results for this indicator (15 out of 16 answers as not at all, limited or moderate extent). Half of the participants had specific references, datasets or tools they had from other building assessments that were useful when assessing the indicator. Here the DGNB certification was useful, energy tools (Be18, BSiM, IDAICE) and the national LCA tool (LCAbyg). All participants had access to the required results from other assessments of the building. The sources for these assessments were the same as above (Be 18, LCAbyg and DGNB).

Major part of the participants (about 75%) did not think that purchasing standards or data for this indicator was a cost barrier and about 65% thought purchasing calculation tools was not a cost barrier.

Larger part of the participants had extensive previous experience with the indicator (11 out of 17), and only a few (2 out of 17) had no or limited experience. Consequently, the use of the indicator did not require extra training and support (11 out of 17 as not at all or in limited extent) and only a few (2 out of 17) needed training and support in great or very great extent.

The value of using Level 2 was by most of the ones answering considered as limited, and very few answered on the value of Level 3.

6.1.2 Indicator 2.3: Construction and demolition waste and materials

The indicator focus on the waste generation at both the construction site taking place in the first life cycle stage of a building and the waste and materials that may arise from deconstruction processes when materials have reached the end of their service life and have to be replaced and at the end of life of the building itself.

TABLE 37. Distribution on Level(s) reporting requirements

	Level 1	Level 2	Level 3
2.3 Construction and demolition waste and materials	13	4	1

Thirteen projects reported on Level 1, four on Level 2 and one on Level 3.

Applicability and ease of use

This section of the survey focuses on construction and demolition waste and materials. Based on their experience with the indicator, the respondents were asked to evaluate whether the indicator was logical and easy to use. Specifically, the participants responded to the following question:

"To what extent was the indicator or life cycle tool easy and logical to use?"

The question above consisted of seven sub-questions, which the participants were asked to respond to. Their responses are summarised in the following table.

TABLE 38. Ease of use – indicator for construction and demolition waste and materials

Q1. To what extent was the indicator or life cyc le tool easy and logical to use?	Not at all	Limited extent	Moderate extent	Great extent	Very great extent	Not relevant to this test
1.1 The guidance for making a common performance assessment provided in the JRC Level(s) documentation	2	4	4	3	2	2
1.2 The calculation method(s) and standards that are specified should be used	2	3	5	2	2	3
1.3 The unit of measurement that is specified should be used	2	1	3	5	5	1
1.4 The reporting format that is provided in the documentation	2	1	8	1	3	1
1.5 The suggested calculation tools and reference data sources	2	4	5	2	2	2
1.6 If used, the Level 2 rules for comparative reporting	1	1	0	2	0	9
1.7 If used, the Level 3 aspects and guidance notes	0	1	0	0	0	12

Note. Projects reported on this indicator: 18/18 - Responses from 17/18.

Table 38 illustrates a general satisfaction with the unit chosen for measurements among the participants (10/17 with great extent and very great extent, and 3/17 with moderate extent). The satisfaction was less with the guidance for making a common performance assessment and the calculation methods. The reporting format provided and the suggested calculation tools and reference data sources distributed around a moderate extent.

For this indicator, four projects reported on Level 2 and one project on Level 3. The responses on if the Level 2 rules for comparative reporting were easy and logical to use were split between approval (2/4 answering great extent) and disapproval (2/4 answering not at all or limited extent). The only project that reported on Level 3 reported that the aspects and guidance notes were easy and logical to use in a limited extent.

The participants were asked to reflect on to what extent the indicator helped them to make a comparison of different building designs. Their responses are shown in Table 39 below.

TABLE 39. Supporting comparison of alternative design options

	Not at all	Limited extent	Moderate extent	Great extent	Very great extent	Not sure
Q2. If comparisons were made of different buildin g design options, to what extent did the indicator or life cycle tool help to do this?	1	0	1	0	1	7

Note. Responses: 10/18

Subsequently, the participants were asked to reflect, to what extent whether they encountered any issues in obtaining the results for the indicator or life cycle tool. Their responses are summarised in Table 40.

TABLE 40. Extent of problems obtaining results

	Not at all	Limited extent	Moderat e extent	Great extent	Very great extent
Q3. To what extent did you encounter any problems in obtai ning a result for the indicator or life cycle tool?	1	1	7	4	4

Note. Responses: 17/18

The results summarized in Table 40 above shows that 7/17 reported that they encountered problems in obtaining a result for the indicator in moderate extent and 8/17 in great or very great extent. Only two projects reported problems in no or limited extent. The type of problems mentioned were:

- Since this building did not have an LCA calculation - and no requirement was made towards the contractors before signing a contract, it was impossible to obtain the relevant data from them. The building does not follow DGNB (or any other sustainability scheme). The contractors were not willing to provide data on the waste materials.
- We do not usually get this kind of information. It is difficult to obtain, and there is a lot of work in sorting the received data in order to report in Level(s).
- We didn’t not have the necessary standards available, which was a problem in obtaining results.
- As consulting engineer it was difficult to obtain the data.
- No data to use.
- The tool does not provide any result.
- It is numbers that are normally not reported in DK and therefor I have very little knowledge of them.
- This existing project was not a part of any certification when it was designed/build, so there had been no talking about or plan of handling the waste at all.

- Since the building later was put though a DGNB-screening, an LCA was made. We therefore used the amount from the LCA (incounting the lifetime and need for replacement).
- It is numbers that are normally not reported in DK and therefor I have very little knowledge of them.
- If the developer or the local authority does not require the contractor to carry out waste-sorting reports and/or schedules, it is difficult to fill in this MO. If the waste-sortering reports are available from the implementation phase the MO level1 and 2 is easy to do. "
- I think the measurement of waste amounts is very relevant and an important parameter. It is not normal procedure in Denmark, so it was difficult to get the information on the waste quantities.
- Deconstruction was not needed on the project. No pre-estimation was made on the construction before starting building.

With regard to renovation cases the respondents added the following comments:

- The problem of acquiring data will be regarding sorting of waste. It is not always possible to sort hazardous waste from non-hazardous waste, as it sometimes cannot be separated and thus ends up being included in the same waste fraction.
- If the developer or the local authority does not require the contractor to carry out waste-sorting reports and/or schedules, it is difficult to fill in this MO. If the waste-sorting reports are available from the implementation phase the MO level 1 and 2 is easy to do.

Accessibility to data, tools and standards

The respondents were asked to specify whether they had used other tools, datasets or references when making the assessments. The responses are summarized as in the table below.

TABLE 41. Use of other references, datasets or tools

	Yes	No
Q4. When making the assessment, were there any other specific references, datasets or tools you had used on other building assessments that proved useful?	4	11

Note. Responses 15/18

In supplementary comments, the respondents referred to the following tools and methods that were useful:

- DGNB criteria TEC 1.6 relating to the amount of material in LCA.
- DGNB LCA tool.
- The data from the DGNB is not sufficient as not all waste data was reported in detail. For DGNB the waste was diverted and sorted correctly but the exact amounts were not accounted for.
- Affaldsforebyggelse I byggeriet Forprojekt, Miljøstyrelsen, Miljøprojekt nr. 1919, January 2017, ISBN: 978-87-93529-66-3. https://www2.mst.dk/Udgiv/publikationer/2017/02/978-87-93529-66-3.pdf.
- Assessment Method Environmental Performance Construction and Civil Engineering Works, Stichting Bouwkwaliteit, Version 2.0 November 2014. www.milieudatabase.nl
- Environmental Profile of Building elements, OVAM, May 2013, http://www.ovam.be

The table below summarises their access to the required results from other previous assessments of the building.

TABLE 42. Access to previous assessments

	Not at all	Limited extent	Moderate extent	Great extent	Very great extent
Q5. To what extent did you already have access to the required results from other assessments of the building?	9	3	1	4	0

Note. Responses: 17/18

The participants identified the following sources of results, which were either available already or diverged from Level(s).

- DGNB PRO 2.1 - waste kg/m2 from construction site
- No data available
- Waste quantities from the contractor
- DGNB assessment
- Some results were available from the LCA in DGNB
- Previous assessment of the building during construction stage where are materials were measured
- The construction site has made monthly reports on waste amounts on the construction site
- The company responsible for the waste management. They made a schedule each month with amount of waste divided into categories

With regard to renovation cases the participants in the national evaluation workshops added the following comments:

- It is difficult to get all the information, as quantities are not calculated in the same way as Level (s). Since no reference point is used, a general way of collecting the data in Level(s) is missing
- No data was available. It is necessary to have other baselines for a renovation project or alternatively separate this indicator into 2 parts: these boundaries are also stated in 2.3.1, however with no mentioning of the processes related to reusing/recycling existing components into the new building, which should be included in the new building life cycle. Also it could be discussed whether it should be allowed to not account for emissions/cost related to the "old building life cycle" as this could potentially distort the intention of reusing/recycling. Part 1: Demolition - Part 2: New construction (this part is then compared with new constructions)

The participants were asked to respond to how available standards, tools or data were. The following Table 43 summarises the responses received.

TABLE 43. Availability of standards, data and/or tools

Q6.If you had to obtain the standards, data and/or tools in order to make the Level(s) assessment, how readily available were they?						
Please answer for each of the following aspects	Not possible to obtain	Difficult to obtain	Some effort to obtain	Easy to obtain	Already had them	*Not relevant to this test building*
6.1 The technical standards used	1	2	2	0	0	11
6.2 The databases used	4	0	3	1	1	7
6.3 Calculation and modelling tools	1	0	2	1	0	12

Note. Responses: 16/18

For technical standards and calculation and modelling tools, the majority answered that this was not relevant for this project, 11/16 and 12/16, respectively. For databases used, 7/16 answered that it was not relevant, but 4/16 that it was impossible to obtain.

The following Table 44 focuses on the cost of the standards, tools or data. For the answers received, a greater amount of projects answered that it would not be a cost barrier if they would have to purchase databases or calculation and modelling tools. But also several projects answered that this would be the main barrier.

TABLE 44. Cost as barrier

Q7. If you had to purchase the standards, data and/or tools, to what extent was their cost a barrier to using them?			
Please answer for each of the following aspects	Not at all	One of the factors	The main factor
7.1 The technical standards used	4	2	4
7.2 The databases used	6	2	3
7.3 Calculation and modelling tools	7	2	1

Note. Responses: 11/18

Competences

The participants were asked to describe the previous experience of the test team with similar indicator or life cycle tools. Their answers are summarised in Table 45 below.

TABLE 45. Previous experience with similar indicators or tools

Q8.	No previous experience	Limited previous experience	Some previous experience	Extensive previous experience
How would you describe the previous experience of the test team with similar indicators or life cycle tools?	4	10	3	0

Note. Responses: 17/18

The number of responses summarised in the table above illustrates, that the main part of the respondents have no or limited previous experience with the indicator. Only three projects had some previous experience with this indicator.

Taking their previous experience into account, the respondents were asked to respond to the question about whether the use of the indicator required additional training and support. Their responses are summarised in the following Table 46.

TABLE 46. Need for additional training

Q9.1	Not at all	Limited extent	Moderate extent	Great extent	Very great extent
Based on the previous experience of the test team, to what extent did using this indicator or life cycle tool require additional training and support?	2	7	3	4	0

Note. Responses: 16/18

Nine out of 16 answered that they would not or only in a limited extent need additional training and support. Seven out of 16 answered that they would need it in a moderate or great extent.

Furthermore, the respondents were asked to elaborate on the type of training, which is required in order to use the indicator or life cycle tool as intended. Their responses are summarised in Table 47 below.

TABLE 47. Areas of additional training

Q9.2	Knowledge of standards or methods	Calculation or modelling tool software use	Access to and handling of data sets	Other (please specify)
If additional training and support was required, please identify the main areas where it was necessary	7	0	0	1

Note. Responses: 8/18

According to the table above the access knowledge of standards and methods was the area where they needed additional training and support. The respondents further identified the type of training and/or support that was needed:

- Basic training by e.g. GBC or national research institute both for consultant and contractors

Table 48 gives an overview of the estimated costs in man days fulfilling the requirement for this particular indicator or tool. Ten respondents have no responses. From the ones responding, about two-third have spent a day or less and about one-third have spent two days.

TABLE 48. Estimated time consumption in man days

Q10.1 If possible please provide an estimate of the cost and/or time that were required to use this indicator or tool.	No response	0.25	0.5	1	2
	10	1	2	4	2

Table 49 gives an overview of the estimated costs in Euros for fulfilling the requirements for the particular indicator or tool. More than half of the respondents have not answered the

question, but the ones responding indicate costs in a very wide range all the way from EUR650 to EUR2,000.

TABLE 49. Estimated cost in Euros

Q10.2 If possible please provide an estimate of the cost and/or time that were required to use this indicator or tool.	No response	650	700	800	1,000	2,000
	12	1	1	1	1	2

Suggestions for improvement

The participants were asked to make suggestions for improvements of the indicator that would make it easier to use. The following suggestions were received:

- I find it hard - and maybe irrelevant - to make a pre-estimate on construction waste. Maybe its better to make a concept on how to reduce waste on site to the entrepreneur
- Data availability depends on project phase. No data available in early phases.
- Not possible to do the assessment.
- "Better description of the meaning of the needed results.
- How should the waste and material date be divided and what is meant with ./. of total mass flow?
- The link between 2.3 and 2.6 is also confusing as there are 2x2.3 in 6.2!
- There are also incorrect date links in 6.2 which I corrected myself."
- It was not possible for us to carry out this assessment, as no one had done it previously and we didn't have the information or the qualifications to make it.
- It would be beneficial to have a database with different building type and the corresponding avg. Waste.
- "National standard for Level(s).
- Level(s) needs to be more simple. The manual is way to technical and should be in less pages.
- There should be some benchmarks for each Levels."
- The tool should be more clear regarding the differences between deconstruction pre-estimate and demolition module D estimate. Unless it's required for both an EoL assessment for the C&D waste material A feedback on the performance and validity of the assessment would be useful as well.
- Further explanation is needed! What does total mass flow cover? And should everything that arrives on site be measured or can it be calculated?
- It could be good to divide the waste into groups of materials, for example concrete, wood and so on. Then it would be possible to see the big waste groups and identify the where it could be possible to decrease waste material.

With regard to renovation cases the participants in the national evaluation workshops added the following comments:

- The problem with the Level(s) indicator for this refurbishment case was to be able to collect the requested data. It has not always been possible to get that data, as the quantities have not been calculated in the same way. A general data input is missing. Likewise, there is no reference point as to whether it is very or little, sustainable or unsustainable what is being reported.
- Further explanation is needed! What does total mass flow cover? And should everything that arrives on site be measured or can it be calculated? Additional guidance is needed

for renovation projects on how to report e.g. divided into a demolition part and a construction part to make comparison easy.

The value of using Level 2 and Level 3

For this indicator, four projects reported on Level 2 and one project on Level 3.

TABLE 50. The value of using Level 2

	Not at all	Limited extent	Moderate extent	Great extent	Very great extent	Not sure
Q12.1 To what extent did Level 2 prove to be useful in making comparisons between buildings?	2	0	0	1	0	4

Note. Responses: 7/18 – 4 projects reported on Level 2

If the value of using Level 2 was moderate or higher, the participants were asked to reflect on how its use influenced the results. Two projects reported that Level 2 proved not at all to be useful in making comparisons between buildings while one project reported it as great extent. The following comments were received:

- Did not make comparisons
- We did not use it to compare because we are testing Level(s) on an existing building. But we think that it could have worked fine for comparisons.
- It would make sense if there was a tool to be used otherwise quantities could not be compared. In relation to design, LCAByg could be used.

TABLE 51. The value of using Level 3

	Not at all	Limited extent	Moderate extent	Great extent	Very great extent	Not sure
Q13.2 To what extent did Level 3 prove useful in obt aining more precise and reliable results?	1	0	0	0	0	5

Note. Responses: 6/18 – 1 project reported on Level 3

Very few answered to this question, but also only one project reported on Level 3 for this indicator, and reported that Level 3 did not prove to be useful in obtaining more precise and reliable results.

Summary

Since the indicator was mandatory, it was tested by all projects. Most projects (13/18) tested the indicator on Level 1. There was a general satisfaction with the unit chosen, while it was less with the guidance given and calculation tools suggested. The participants encountered several problems in obtaining the results since the indicator requires numbers that are not normally reported in Denmark. The participants reported that DGNB certification (both PRO 2.1, TEC 1.6 and LCA) as specific references, datasets and tools that were helpful for this indicator, although this could not be used directly. The renovation cases reported that it was difficult to get data for this indicator. Most participants had limited previous experience (10/17), while few (4/17) had no and few (3/17) had some previous experience with working with similar indicator. Nevertheless, only one fourth reported that they needed training in great extent.

6.1.3 Indicator 3.1 Use stage water consumption

The indicator focus on calculating the use stage water consumption in the building per occupant at both daily and annual level. The focus is on sanitary devices/fittings and water consuming appliances for a particular building. The evaluation is flexible for users to define usage factors (i.e. how many minutes a person is in the shower per day etc.) and occupancy rates (i.e. how many days per year the building is occupied) in order to be able to adapt to different assumptions used in different tools and regions. A calculation tool is provided to carry out the assessment.

TABLE 52. Distribution on Level(s) reporting requirements

	Level 1	Level 2	Level 3
3.1 Use stage water consumption	11	8	1

Eleven projects reported on Level 1, eight on Level 2 and one on Level 3. In total nineteen reports were received, and therefore one project reported on two levels.

6.1.4 Applicability and ease of use

This section of the survey focuses on use stage water consumption. Based on their experience with the indicator, the respondents were asked to evaluate whether the indicator was logical and easy to use. Specifically, the participants responded to the following question:

"To what extent was the indicator or life cycle tool easy and logical to use?"

The question above consisted of seven sub-questions, which the participants were asked to respond to. Their responses are summarised in the following Table 53.

TABLE 53. Ease of use – indicator for use stage water consumption

Q1. To what extent was the indicator or life cycle tool easy and logical to use?	Not at all	Limited extent	Moderate extent	Great extent	Very great extent	Not relevant to this test
1.1 The guidance for making a common performance assessment provided in the JRC Level(s) documentation	0	4	7	3	3	0
1.2 The calculation method(s) and standards that are specified should be used	0	4	2	9	2	0
1.3 The unit of measurement that is specified should be used	0	3	2	10	2	0
1.4 The reporting format that is provided in the documentation	0	2	7	6	2	0
1.5 The suggested calculation tools and reference data sources	0	2	6	6	3	0
1.6 If used, the Level 2 rules for comparative reporting	0	1	3	3	2	2
1.7 If used, the Level 3 aspects and guidance notes	0	1	0	0	0	8

Note. Projects reported on this indicator: 18/18 - Responses from 17/18.

Table 53 illustrates a general satisfaction among the participating projects with the calculation methods and standards and the unit chosen for measurements (11/18 and 12/18 with great to very great extent respectively). The satisfaction with the reporting format and

the calculation tools and reference data sources is a bit less, it distributes around moderate extent to great extent. The acceptance of the guidance for making the assessment method distributes around moderate extent.

For this indicator, eight projects reported on Level 2 and one project on Level 3. The experiences of using Level 2 are almost spread out through the whole scale – from a limited extent to a very great extent. Only one project tested Level 3 and reported with limited extent.

The participants were asked to reflect on to what extent the indicator helped them to make a comparison of different building designs. Their responses are shown in Table 54 below.

TABLE 54. Supporting comparison of alternative design options

	Not at all	Limited extent	Moderate extent	Great extent	Very great extent	Not sure
Q2. If comparisons were made of different buildin g design options, to what extent did the indicator or life cycle tool help to do this?	1	2	1	1	0	6

Note. Responses: 11/18

Subsequently, the participants were asked to reflect, to what extent whether they encountered any issues in obtaining the results for the indicator or life cycle tool. Their responses are summarised in Table 55.

TABLE 55. Extent of problems obtaining results

	Not at all	Limited extent	Moderat e extent	Great extent	Very great extent
Q3. To what extent did you encounter any problems in obtai ning a result for the indicator or life cycle tool?	4	10	2	2	0

Note. Responses: 18/18

The results summarized in Table 55 above shows that the participants generally did not ecounter problems in great extent (14/18 as not at all or limited extent, and 4/18 in moderate to great extent). The type of problems mentioned were:

- In Denmark we don't asses the water used pr. day for all taps. We have standards for the hot watertaps in relation to the size of the hot water tank, but not for the cold water.
- The reporting tool doesnt give any result about the indicator it's just reporting the values given by the user.
- Depending on the country and river basin you choose in the calculation tool some columns come and go. Some cells disappear when choosing Denmark Sealand, which might be correct according to calculation, but there is no descriptions of why this happens.
- For our project, several water analyzes and assessments of water were made in the project, as well as selected water saving fixtures. Therefore, the information would be relatively easy to access. However, in other cases that do not, for example, treat water, it would be more difficult and perhaps unrealistic to collect the data, as it was not affected in the renovation case.
- Minor recalculation necessary from DGNB water calculation to Level(s) reporting.

Accessibility to data, tools and standards

The respondents were asked to specify whether they had used other tools, datasets or references when making the assessments. The responses are summarized in Table 56 below.

TABLE 56. Use of other references, datasets or tools

	Yes	No
Q4. When making the assessment, were there any other specific references, datasets or tools you had used on other building assessments that proved useful?	12	6

Note. Responses: 18/18

In supplementary comments, the respondents referred to the following tools and methods that were useful:

- The unit of measurement that is specified should be used.
- DGNB Water assessment tool.
- In DGNB the amount of sewage from the building and the amount of derived rainwater is also included in the inventory and the evaluation of handling water in a sustainable way. As well the DGNB has standard values that are great.
- The tool for assessment from EEA was used. This can be found under the following link: https://www.eea.europa.eu/data-and-maps/indicators/use-of-freshwater-resources-2/assessment-3.

Table 57 below summarises their access to the required results from other previous assessments of the building.

TABLE 57. Access to previous assessments

	Not at all	Limited extent	Moderate extent	Great extent	Very great extent
Q5. To what extent did you already have access to the required results from other assessments of the building?	3	1	3	7	4

Note. Responses: 18/18

The participants identified the sources of results, which were either available already or diverged from Level(s). The majority of the comments (in total 11 comments) were related to the usefulness of the DGNB water calculator (criterion ENV 2.2). One commented that the tool provided by Level(s) could be used to supplement the information from DGNB certification. Other suggested that building plans with services drawn on and a list of total kitchen taps, showers and so on could be used as data source.

The participants were ask to respond to how available standards, tools or data were. The following Table 58 summarises the responses received.

TABLE 58. Availability of standards, data and/or tools

Q6.If you had to obtain the standards, data and/or tools in order to make the Level(s) assessment, how readily available were they?						
Please answer for each of the following aspects	Not possible to obtain	Difficult to obtain	Some effort to obtain	Easy to obtain	Already had them	*Not relevant to this test building*
6.1 The technical standards used	1	1	3	2	5	4
6.2 The databases used	1	0	3	5	4	3
6.3 Calculation and modelling tools	1	0	1	3	9	2

Note. Responses: 16/18

From the answers given in Table 58 above, it does not seem that the availability of technical standards, databases and calculation and modelling tools are problematic to obtain.

The following Table 59 focuses on the cost of the standards, tools or data. From the total 14-15 answers received, about half projects answered that it would not be a cost barrier if they would have to purchase databases or calculation and modelling tools. The other half was distributed between one of the factors or the main factors, and where technical standards were identified as the main barrier in one-third of the answers.

TABLE 59. Cost as barrier

Q7. If you had to purchase the standards, data and/or tools, to what extent was their cost a barrier to using them?			
Please answer for each of the following aspects	Not at all	One of the factors	The main factor
7.1 The technical standards used	6	3	5
7.2 The databases used	9	4	2
7.3 Calculation and modelling tools	7	5	2

Note. Responses: 15/18

Competences

The participants were asked to describe the previous experience of the test team with a similar indicator or life cycle tools. Their answers are summarised in Table 60 below.

TABLE 60. Previous experience with similar indicators or tools

Q8.	No previous experience	Limited previous experience	Some previous experience	Extensive previous experience
How would you describe the previous experience of th e test team with similar indicators or life cycle tools?	3	3	5	6

Note. Responses: 17/18

The number of responses summarised in the table above illustrates, that 11/17 of the respondents some or extensive previous experience with the indicator. But about one third (7/17) had no or limited previous experience.

Taking their previous experience into account, the respondents were asked to respond to the question about whether the use of the indicator required additional training and support. Their responses are summarised in the following Table 61.

TABLE 61. Need for additional training

Q9.1	Not at all	Limited extent	Moderate extent	Great extent	Very great extent
Based on the previous experience of the test team, to what extent did using this indicator or life cycle tool require additional training and support?	9	4	2	1	0

Note. Responses: 16/18

The majority (13/16) answered that they would not or only in limited extent need additional training and support, and an only limited amount of projects (3/16) would need it in moderate or great extent.

Furthermore, the respondents were asked to elaborate on the type of training, which is required in order to use the indicator or life cycle tool as intended. Their responses are summarised in Table 62 below. Very few answers were received only five out of 18 projects.

TABLE 62. Areas of additional training

Q9.2	Knowledge of standards or methods	Calculation or modelling tool software use	Access to and handling of data sets	Other (please specify)
If additional training and support was required, please identify the main areas where it was necessary	2	2	1	0

Note. Responses: 5/18

Table 63 gives an overview of the estimated costs in man days fulfilling the requirement for this particular indicator or tool. 6 of the respondents have not replied. From the ones responding, all of them have spent a day or less.

TABLE 63. Estimated time consumption in man days

Q10.1 If possible please provide an estimate of the cost and/or time that were required to use this indicator or tool.	No response	0.1	0.25	0.5	0.75	1
	6	1	1	5	1	4

Table 66 gives an overview of the estimated costs in Euros for fulfilling the requirements for the particular indicator or tool. Half of the respondents have not answered the question. The responses indicate a very a wide range of the estimated costs, all the way from EUR20 to EUR1,300.

TABLE 64. Estimated cost in Euros

Q10.2 If possible please provide an estimate of the cost and/or time that were required to use this indicator or tool.	No response	20	350	500	780	800	1,000	1,300
	9	1	1	2	1	1	1	1

Suggestions for improvement

The participants were asked to make suggestions for improvements of the indicator that would make it easier to use. The following suggestions were received:

- The calculation tool works well.
- Difficult to compare to other buildings. No performance basis.
- The section on greywater collection disappear when some River Basins are chosen.
- The level water calculator didn't work in order to achieve results for Part 2! There are no part for water use for cleaning!?
- Easy-to-use calculation tool. Nice to see the water consumption in a pie chart - maybe consider to use this visual approach in some of the other indicators.
- "National standard for Levels.
- Levels need's to be more simple. The manual is way to technical and should be in less pages.
- There should be some benchmarks for each Levels."
- The specific indicator is relatively easy to use for levels 1 and 2. Level 3 is more complicated to use and to understand, as it requires very specific data, which is difficult to obtain. Thus more focus should be based on making simpler Level 3. However it hasn't been assessed for this project thus no specific suggestions can be provided. A feedback on the performance and validity of the assessment would be useful as well
- Easy to use and understand.
- "This indicator and the following tool Levels_Beta_1.1_Water_calc is easy to use.
- The choice of country chances the input areas - maybe an explination of why this happens could be nice in the excel-tool. "
- "Same units! These must be converted!
- A suggestion for at missing part: Cleaning of the building.
- There are no mandatory tools that must be used, therefore no DGNB Water calculation ENV2.2 needs to be performed, but clearly time-saving if it is done too.
- It is possible to save time on finding the correct data, by using Level (s) water calculations tool.
- There is dispute between Level(s) and DGNB in relation to the number of seconds the fitting/tabs uses."
- "Acknowledge that there are differences in countries how water consumption is measured. Eg grey water is different in various countries.
- For a building in use, the data regarding the water consumption in different sources (e.g. appliances, fittings and devices) is very often not available therefore such a differentiation is not easily reachable. In addition to that, it is not clear from the guidance, what is achieved by splitting the water consumption in the proposed categories and the additional information that the user can have from that. On the contrary the possibility of splitting between hot and cold water, which is a rather useful distinction is not feasible, even though this is something that can be derived from actual measurement and consumption data. "
- Easy to use, and easy to find data from DGNB calculations.

- For major renovations, you will make water calculations and choose water saving fixtures, etc. There will also be financial subsidy if rainwater discharge is not connected to the sewer - therefore other options are considered and optimizations and comparisons are made between several options. But if for example only windows are renovated - it does not make sense to look at this micro objective.
- Same units! These must be converted!
- A suggestion for at missing part: Cleaning of the building
- There are no mandatory tools that must be used, therefore no DGNB Water calculation ENV2.2 needs to be performed but clearly time-saving if it is done too.
- It is possible to save time on finding the correct data, by using Level (s) water calculations tool.
- There is dispute between Level(s) and DGNB in relation to the number of seconds the fittings/tabs uses.
- This indicator can easily be conducted for renovation projects."

The value of using Level 2 and Level 3

For this indicator, eight projects reported on Level 2 and one project on Level 3. From the tables below it can be seen that also projects that didn't report on Level 2 and Level 3 also answered on the following questions. From table 65 below, it can be seen that over half answered that there was no or limited value of using Level 2 (7/12).

TABLE 65. The value of using Level 2

	Not at all	Limited extent	Moderate extent	Great extent	Very great extent	Not sure
Q12.1 To what extent did Level 2 prove to be useful in making comparisons between buildings?	2	5	1	1	1	2

Note. No response: 6

If the value of using Level 2 was moderate or higher, the participants were asked to reflect on how its use influenced the results. The following comments were received:

- Much better comparisons, as the time use is difficult to estimate.
- We did not use it to compare because we are testing Level(s) on an existing building. But we think that it could have worked fine for comparisons.

TABLE 66. The value of using Level 3

	Not at all	Limited extent	Moderate extent	Great extent	Very great extent	Not sure
Q13.2 To what extent did Level 3 prove useful in obtaining more precise and reliable results?	1	0	1	0	0	4

Note. No response: 12

Only one project reported on Level 3 and therefore very few answers were received. One project had the following comments:

- Breakdown of performance by operational water uses and water grade.
- Optimization aspects addressed.
- More advanced stages to test. More ambitious than DGNB. Level 3 is most relevant if considerations of multiple usage scenarios is done in an early stage at the project.

Summary

The participant were generally satisfied with the unit chosen, the calculation method, calculation tool, references and the guideline provided. About half of the teams tested this indicator on Level. Only few participants encountered problems when working with the indicator and many had experience with working with similar assessment in a DGNB project. The level of previous experience with working with similar indicators was spread out over the whole scale from no experience to extensive previous experience. It can be concluded that working with the indicator was relatively easy since only few project teams needed additional training to carry out the work with the indicator.

6.1.5 Indicator 4.1: Indoor air quality

Indicator 4.1 Indoor air quality addresses two sub-elements, namely good indoor air quality and pollutants. The indicators for good indoor air quality measure the three main parameters identified in EN 15251 and EN 16978 as being important to the provision of a healthy and comfortable indoor air supply to occupants: ventilation (rate of air change), CO_2 levels and relative humidity. The indicators for source control of target air pollutants measure the most significant potential hazards to human health that can enter indoor air like, e.g. radon, formaldehyde and benzene (JRC – Joint Research Centre, European Commission (2017a: 49).

Table 67 shows the distribution of projects testing this indicator on each of the three levels. More than half of the projects have tested this indicator on Level 1, and almost one-third has tested the indicator on Level 3.

TABLE 67. Distribution on Level(s) reporting requirements

	Level 1	Level 2	Level 3
4.1 Indoor air quality	13	1	5

Applicability and ease of use

This section of the survey focuses on indoor air quality. Based on their experience with the life cycle tool, the respondents were asked to elucidate whether the life cycle tool or indicator was logical and easy to use. Specifically, the participants responded to the following question:

“To what extent was the indicator or life cycle tool easy and logical to use?”

The question above consisted of seven sub-questions, which the participants were asked to respond to. Their responses are summarised in Table 68 below.

TABLE 68. Ease of use – indicator for Indoor air quality

Q1. To what extent was the indicator or life cycle tool easy and logical to use?	Not at all	Limited extent	Moderate extent	Great extent	Very great extent	Not relevant to this test
1.1 The guidance for making a common performance assessment provided in the JRC Level(s) documentation	1	7	7	1	1	0
1.2 The calculation method(s) and standards that are specified should be used	2	6	5	3	1	0
1.3 The unit of measurement that is specified should be used	1	4	6	5	1	0
1.4 The reporting format that is provided in the documentation	1	1	7	7	0	1
1.5 The suggested calculation tools and reference data sources	3	6	3	3	0	2
1.6 If used, the Level 2 rules for comparative reporting	0	0	1	0	0	8
1.7 If used, the Level 3 aspects and guidance notes	0	0	1	0	0	8

Note. 17 out of 18 projects reported on this indicator.

Table 68 above illustrates that the indicator or life cycle tool is only to a limited or moderate extent logical and easy to use with regard to:

- the guidance for making a common performance assessment,
- calculation methods and standards,
- the unit of measurement, and
- the suggested calculation tools and reference data sources.

Furthermore, the table illustrates that the indicator is moderate or to a great extent easy to use in relation to the reporting format. Finally, the requirements for Level 2 and Level 3 are deemed irrelevant by half of the respondents reflecting that few case buildings have applied more than Level 1 in the test.

The participants were asked to reflect on to what extent the indicator helped them to make a comparison of different building designs. Their responses are shown in Table 69 below.

TABLE 69. Supporting comparison of alternative design options

	Not at all	Limited extent	Moderate extent	Great extent	Very great extent	Not sure
If comparisons were made of different building design options, to what extent did the indicator or life cycle tool help to do this?	1	2	2	1	0	5

Note. No responses: 7

Subsequently, the participants were asked to reflect on to what extent they encountered any issues in obtaining the results for the indicator or life cycle tool. Their responses are summarised in Table 70.

TABLE 70. Extent of problems obtaining results

	Not at all	Limited extent	Moderate extent	Great extent	Very great extent
To what extent did you encounter any problems in obtaining a result for the indicator or life cycle tool?	1	1	4	8	3

Note. No response: 1

The results summarized in Table 70 above show that most respondents have encountered problems to a great or very great extent, whilst some of them have encountered problems to a moderate extent. The type of problems, which the respondents have encountered, are listed below:

- Limited experience in this field.
- It was unclear whether the calculated airflow used in the building design should be translated into an indoor category according to EN15251 in Leve(s).
- Some of the results are not handled in DGNB or this project, or it is not known how to gather the information.
- It is not understood what is meant by LCI and many of the results are not achievable in Denmark for the specific building product.
- We did not have the necessary standards available, which was a huge problem in obtaining results. As architects we are not able to carry out this assessment.
- I initially did not have access to EN16798.
- The data provided from the materials was stated in different units so the calculation was not useful for us.
- The tools yield no results. Thus no assessment of the given values was possible.
- Difficult to establish the data.
- Obtaining results for this indicator in general (mostly design stage 2) was difficult because the project and building was finished years ago, and there had been no extensive focus on emissions from materials. Therefore, only design values and test values (regarding ventilation and mould) can be reported for the actual project. Ventilation and mould was mandatory to handle in the Danish building regulation at the time the project was planned. Emissions have only gained momentum and interest among general building designers over the past few years in Denmark.
- Question: Why is the Post-completion stage 1 and 2 and Occupation stage 1 and 2 placed under 'Level 3' in the reporting tool? In the manual part 3, these subjects are explained under 'Level 1'.
- Question: Why not look at the total VOC (TVOC) result by making a measurement at the end of the construction phase like it is done in DGNB?
- The guidance should differentiate between indicators that have to be reported in any case and indicators that are optional since they are not relevant for all buildings and highly expensive. The overall approach and parameters seem to be fine. However, the guidance in relation to the reporting format and the 3 levels may be confusing, at least for level 1 for existing buildings.
- Especially for existing buildings, indoor air quality is relevant and actionable, e.g. to adapt ventilation strategies related to occupancy. This is not clear from the reporting approach. While on the other hand users may interpret, that measurements must be carried out, e.g. for benzene or radon, even when there are no requirements or complaints. Measurements are costly, and unnecessary actions should be avoided.
- The guidance is long reading with all kinds of examples and tables; without the reporting format one could get lost on what to report for which level. A more straightforward approach and clarity as to what the 3 levels aim at would be helpful.

- It is difficult to get data on the individual products. However, I think the criterion is important. However, one should consider whether VOC in building parts should be in Level 1.
- EN16798 and EN 13779 were not possible to obtain. Indicator 4.1.2 have no results in the project.
- When carrying out measurements with regard to degassing, it is carried out for entire rooms and for all the existing materials in the building together. It is difficult to find degassing for individual products as manufacturers usually only indicate content in the product and not the actual degassing. Therefore, I lack an overall assessment of content in relation to degassing. However, if eco-labelled products are selected, it is ensured that there is no toxic content.
- Missing a general input in Level(s). No testing of the building regarding infiltration was made, but the ventilation rates were calculated.

Accessibility to data, tools and standards

The respondents were asked to specify whether they had used other tools, datasets or references when making the assessments. The responses are summarized in Table 71 below.

TABLE 71. Use of other references, datasets or tools

	Yes	No
When making the assessment, were there any other specific references, datasets or tools you had used on other building assessments that proved useful?	6	11

Note. No response: 1

In the supplementary comments, the respondents referred to the following tools, references or datasets from previous projects:

- DGNB, in particular the criteria SOC 1.2 (indoor air quality) and ENV 1.2 (Environmental risks related to building products) along with TEC1.3 indicator 4 regarding moist and mould prevention.
- The building simulation tool BSim.
- EN16798-1 Table I.4 and the Danish approach for measuring CO_2 concentration.

Table 72 below summarises the respondents' access to the required results from other previous assessments of the building.

TABLE 72. Access to previous assessments

	Not at all	Limited extent	Moderate extent	Great extent	Very great extent
To what extent did you already have access to the required results from other assessments of the building?	4	5	6	2	0

Note. No response: 1.

The participants identified the following sources of results, which were either available already or diverged from Level(s). The comments may be grouped in three related to availability due to DGNB certification of the project, results from typical test, measurements and calculations, and differences identified:

- DGNB certification:
  - In particular the criteria SOC 1.2 and ENV 1.2.

    - All parameters in Level 1, design stage 1 and most of parameters in level 1, design stage 2 were available, because a DGNB certification had been carried out.
    - If it were not for the DGNB certification, several areas would not have been investigated. There are no requirements for renovation.
- Results from typical test, measurements and calculations:
    - The airflow was calculated during building design.
    - The test of ventilation rate was tested in relation to the commissioning of the finished building.
    - Measurements were done for relative humidity, radon and CO_2 but not for the others during the use of the building.
- Differences in methods:
    - The units from products wanted in Level(s) does not match the units written in Danish datasheets.
    - Stage 2 is not filled out since the measurement units are not exactly the same as the safety data sheets in Denmark would provide.
    - EN16798 and EN13779 were not possible to obtain.

The participants were asked to respond to the availability of standards, tools or data. The following Table 73 summarises the responses received. The respondents experienced some or more difficulties in getting access to relevant technical standards, databases and calculation and modelling tools.

TABLE 73. Availability of standards, data and/or tools

Q6.If you had to obtain the standards, data and/or tools in order to make the Level(s) assessment, how readily available were they?						
Please answer for each of the following aspects	Not possible to obtain	Difficult to obtain	Some effort to obtain	Easy to obtain	Already had them	*Not relevant to this test building*
6.1 The technical standards used	5	4	5	2	1	0
6.2 The databases used	2	4	5	1	1	4
6.3 Calculation and modelling tools	2	2	2	3	2	6

Note. No response: 1.

The following Table 74 focuses on the cost of the standards, tools or data. The respondents tend to be divided equally on whether the cost of purchasing standards, data and/or tools is a barrier or not.

TABLE 74. Cost as barrier

Q7. If you had to purchase the standards, data and/or tools, to what extent was their cost a barrier to using them?			
Please answer for each of the following aspects	Not at all	One of the factors	The main factor
7.1 The technical standards used	6	4	3
7.2 The databases used	5	2	4
7.3 Calculation and modelling tools	7	2	4

Competences

The previous experience of the respondents with a similar indicator or life cycle tools are summarised in Table 75 below. The number of responses summarised in the table above illustrates, that the main part of the respondents has either limited or some previous experience with similar tools.

TABLE 75. Previous experience with similar indicators or tools

Q8.	No previous experience	Limited previous experience	Some previous experience	Extensive previous experience
How would you describe the previous experience of th e test team with similar indicators or life cycle tools?	3	7	7	0

Taking their previous experience into account, the respondents were asked to respond to the question about whether they require additional training in order to use the indicator or life cycle tool. Their responses are summarised in the following Table 76. The majority of respondents have indicated that the use of life cycle tools and indicators requires additional training to a moderate extent, while some have indicated that the training is required to a limited extent.

TABLE 76. Need for additional training

Q9.1	Not at all	Limited extent	Moderat e extent	Great extent	Very great extent
Based on the previous experience of the test team, to what extent did using this indicator or life cycle tool require additional training and support?	2	4	8	2	1

Furthermore, the respondents were asked to elaborate on the type of training, which is required in order to use the indicator or life cycle tool as intended. Their responses are summarised in Table 77 below.

TABLE 77. Areas of additional training

Q9.2	Knowledge of standards or methods	Calculation or modelling tool software use	Access to and handling of data sets	Other (please specify)
If additional training and support was required, please identify the main areas where it was necessary	11	4	8	2

According to the table above additional training is required in the two main areas:

- Knowledge of standards or methods.
- Access to and handling of data sets.

Other areas where additional training is required are:

- To access the data necessary to assess the criteria.
- The data required for completion of the report require some specific knowledge and expertise skills in simulation tools. Thus, support by specialists is necessary in order to obtain the required data.
- Specific knowledge of emissions from materials and the measurement units used compared to the Danish safety sheet.

- Knowledge about emissions from materials in general, more about measurement/unit opportunities. Some key values would also be nice to have in order to relate to one's own project.
- Further work was required with LCI and formaldehyde, as it was unclear how to report e.g. should several paints be reported or should a limit value be reported e.g. the worst case?
- Due to financial constraints additional training was not purchased. Neither did we use any specialists to do measurements.
- Study on how to get data for degassing in relation to specific materials. In addition, also time to investigate possible standards in relation to Level(s) requirements and which Danish standards they correspond to.

Table 78 gives an overview of the estimated costs in man days for fulfilling the requirement for this particular indicator or tool. More than one-third of the respondents have not replied, about one-third have spent a day or less, and a smaller group has spent 4 or more days. It is not clear whether the last group of answers is effectively covering the entire test or just this indicator or tool.

TABEL 78. Estimated time consumption in man days

Q10.1 If possible please provide an estimate of the cost and/or time that were required to use this indicator or tool.	No response	0.2	0.25	0.5	1	4	5 or more	25
	7	1	1	1	4	2	1	1

Table 79 gives an overview of the estimated costs in Euros for fulfilling the requirement for this particular indicator or tool. More than half of the respondents have not answered the question. The responses cover a very wide range all the way from EUR40 to EUR25,000 with an average around EUR1,000.

TABLE 79. Estimated cost in Euros

Q10.2 If possible please provide an estimate of the cost and/or time that were required to use this indicator or tool.	No response	40	230	700	800	1,000	1,300	3,840	25,000
	10	1	1	1	1	1	1	1	1

Suggestions for improvement

Furthermore, the participants were asked to make suggestions for improvement of the indicator or life cycle tool. The suggestions are listed as below:

- In DGNB, formaldehyde and TVOC is measured before the building is handed over to the client – not specifically benzene and PM2,5/10. It is difficult to set the VOC target air pollutants for source control during Design stage 2.
- More clear and precise guidance on how to fill out the fields for the indicator in Denmark (a national interpretation would be relevant). Or perhaps give examples (more specific than the "Level 1 common performance reporting format" in the guide).
- There are no guide for what is to be placed in the section "other" for indicator 4.1.2. In Denmark it is difficult to achieve results for building products – a test is made for the combination of all emissions – can this be noted under "other"? Radon is to be evaluated if relevant – but it is not stated when this is?
- It was not possible for us to carry out this assessment as no one had done it previously and we did not have the information or the qualifications to make it.

- Fairly simple and easy to fill in. General note: Pre-testing in the design phase of pollutants is not common procedure in Denmark.
- Develop a national standard for Level(s). Level(s) needs to be more simple. The manual is way too technical and should be in less pages. There should be some benchmarks for each Level(s).
- The tool requires data that demands a lot of work and expert knowledge in order to be documented properly. There is an incoherent placement of tables which makes it unclear what stages are under what level. A bit of attention should be paid there in order to be clear to the users what stages they have to report. In addition the required data are many and hard to be found. Thus a simplified method or approach for at least Level 1 is recommended. A feedback on the performance and validity of the assessment would be useful as well.
- Even though stage 2 is not filled out the objective makes sense in the choice of which materials to use.
- When testing for the Post-completion stage 1, more cells to report values for amount of air would be a good thing. The design stage 2 seems very meaningful.
- Ventilation rate is part of the energy performance framework and is a part of ENV1.1 in DGNB. Other parameters from Level 1 is part of DGNB or the Danish Building Regulations. There is therefore not much extra work in Level 1 design stage 1. Level 1 design stage 2: It is possible to get the most information on degassing of building materials from safety data sheets. It may be a little vague to read the table as there are no limits to the degassing results. Comparable to DGNB criterion ENV1.2, however less voluminous due to fewer materials in the table. A bit hard to fill in "LCI: Lowest concentration of interest" because the use of this indicator is not widespread.
- A more straightforward approach and clarity on what the 3 levels aim at would be helpful. Additionally, a distinction between mandatory and optional based on each case, emissions, should be required. It is not easy or cheap to obtain these results so it is often not feasible.
- Annex I from the standard could be typed into the reporting tool.
- There are several areas where the level of detail is too large. More general focus areas should be created. Similarly, there is a need for adaptation to Danish standards and opportunities, as all information has not been possible to introduce.
- This indicator even refers to renovation projects, so this is easy to use in renovation projects (regarding mould inspections prior to renovation). It will be difficult to fill out the indicator 4.1.2 for existing building materials in a renovation project, so it should be described better with a specific guidance for renovation projects. In general it may be very hard for renovation projects to achieve thermal qualities according to current standards. The example project we looked into for this test did not achieve any points at all in the DGNB credit TEC1.3. E.g. the U-values for new building components met current regulation, but existing building parts did not. Perhaps it should be possible to distinguish benchmarks for new buildings and renovation projects?

The value of using Level 2 and Level 3

For this indicator, 1 projects reported on Level 2 and 5 projects on Level 3. Still, 7 project teams have answered the question. The 7 answers display that either the effect is limited or the effect of using Level 2 is uncertain (Table 80).

TABLE 80. Indicator 4.1 – the value of using Level 2

	Not at all	Limited extent	Moderate extent	Great extent	Very great extent	Not sure
Q12.1 To what extent did Level 2 prove to be useful in making comparisons between buildings?		3				4

Note. Responses: 7/18 – 1 project reported on Level 2

With regard to the usefulness of applying Level 2 the respondents added the following comments:

- Not used, although it seems comprehensive to compare all the parameters.
- 1 of 4 parameters is presented in DGNB. The remaining 3 are "more advanced" than DGNB.

The 7 answers regarding the use of Level 3 display that the effect is assessed as uncertain except for 1 response indicating that the value may be great (Table 81).

TABLE 81. Indicator 4.1 – the value of using Level 3

	Not at all	Limited extent	Moderate extent	Great extent	Very great extent	Not sure
Q13.2 To what extent did Level 3 prove useful in obtaining more precise and reliable results?		1		1		5

Note. Responses 7/18 – 5 projects reported on Level 3

With regard to the usefulness of applying Level 3 the respondents added the following comments:

- Not used.
- Important field to perform, but rather advanced, because of the follow-up measurements at the in-use stage.

Summary

With regard to the applicability of this indicator on indoor air quality, the major part of respondents finds the indicator only to a limited or moderate extent logical and easy to use. Indeed, the respondents reported a number of problems encountered in obtaining the results for this indicator.

With regard to accessibility of data, tools etc., the participants have mainly used tools, datasets or references from DGNB certification, the standard EN 16798 and the simulation tools BSim and IDA Indoor Climate and Energy.

With regard to competences, the participants had limited or moderate previous experience. Hence they found it necessary to require additional support or training in order to fulfil the tasks. They mainly identified knowledge of standards and methods as well as access to and handling datasets as the main areas where additional training is required.

6.1.6 Indicator 4.2: Time out of thermal range

Indicator 4.2 Time out of thermal range focus on the ability of the building to maintain pre-defined thermal comfort conditions during the heating and cooling seasons as defined by EN ISO 7730. By proxy, the indicator measures the proportion of the year when building occupiers may feel thermal discomfort based on either calculated or measured performance.

The indicator is the internal operating temperature and comfort condition of the occupiers within the building (JRC – Joint Research Centre, European Commission (2017a: 52).

Table 82 shows the distribution of projects testing this indicator on each of the three levels. Approximately two-thirds of the projects have tested this indicator on Level 1, and almost one-fourth has tested the indicator on Level 2 or Level 3.

TABLE 82. Distribution on Level(s) reporting requirements

	Level 1	Level 2	Level 3
4.2 Time out of thermal comfort range	11	4	5

Applicability and ease of use

This section of the survey focuses on time out of the thermal range. Based on their experience with the indicator, the respondents were asked to elucidate whether the indicator was logical and easy to use. Specifically, the participants responded to the following question:

"To what extent was the indicator or life cycle tool easy and logical to use?"

The question above consisted of seven sub-questions. The responses are summarised in Table 83. The responses with regard to logical and easy use of the indicator are distributed more evenly around a moderate extent. Hence, the extreme positive or negative values are less pronounced with regard to this indicator.

TABLE 83. Ease of use – indicator for Time out of thermal range

Q1. To what extent was the indicator or life cyc le tool easy and logical to use?	Not at all	Limited extent	Moderate extent	Great extent	Very great extent	Not relevant to this test
1.1 The guidance for making a common performance assessment provided in the JRC Level(s) documentation	0	5	7	4	0	0
1.2 The calculation method(s) and standards that are specified should be used	0	5	3	5	2	1
1.3 The unit of measurement that is specified should be used	0	4	3	6	3	0
1.4 The reporting format that is provided in the documentation	1	3	7	4	1	0
1.5 The suggested calculation tools and reference data sources	0	4	7	3	1	1
1.6 If used, the Level 2 rules for comparative reporting	1	3	1	0	1	3
1.7 If used, the Level 3 aspects and guidance notes	0	0	1	3	1	4

Note. 16 projects reported on this indicator, except for the last 2 questions answered by 9 projects.

Table 84 below focuses on the potential of the indicator or life cycle tool to make comparisons between different building designs. Only two-thirds have answered this question, and half of those respondents are not sure. Most of the actual answers see limited or no support for alternative design options.

TABLE 84. Supporting comparison of alternative design options

Q2.	Not at all	Limited extent	Moderate extent	Great extent	Very great extent	Not sure
If comparisons were made of different building design options, to what extent did the indicator or life cycle tool help to do this?	2	2	0	0	1	6

Note: 11 out of 18 responses.

The participants were asked to reflect on whether they have encountered any issues in obtaining the results for the indicators. Their responses are summarised in Table 85, which shows that the respondents have to a moderate to great or even very great extent encountered problems in obtaining results.

TABLE 85. Extent of problems obtaining results

Q3.	Not at all	Limited extent	Moderate extent	Great extent	Very great extent
To what extent did you encounter any problems in obtaining a result for the indicator or life cycle tool?	1	2	7	4	2

Note: 16 projects out of 18 answered.

The respondents have identified other problems, which they encountered while using the indicator:

- The building is not designed according to any scheme (e.g. DGNB), hence it was fairly time consuming to do extra simulations according to EN standards for part 2 and 3, and simulate time out of range without mechanical systems.
- Some of the results are not dealt with in Denmark or in this project (or it is not known how to gather the information in this project).
- As architects, we are not able to carry out this assessment.
- I did not initially have access to EN 16798.
- Once again the tool does not provide any results. The input values were obtained by DGNB measurements.
- EN16798 is not available, so there are questions that cannot be answered.
- Results for the time out of range without mechanical heating and cooling does not make sense in Denmark, because the regulation states that a heating system is required. Of course it can be interesting to look at only the passive design effects, but in Denmark this is not common practice to simulation. It's not simulated for this project.
- It is difficult to state/report the accepted tolerance limits for hours out of range. One can only note the result, but isn't the range interesting?
- Question: Why did one need to report the energy performance assessment tool within part 1? The performance assessment of indoor temperature was (in this and among many other Danish buildings) made in a tool not related to the energy calculation. It's called BSim. That being said, more residential buildings uses the newer energy-tool-related program in Denmark.
- Question: Why is the part 3 manual p. 145 and the Rating Aspect scheme not alike?
- EN 16798 Annex H.1 is not available so the questions in 'Part 3' in the report scheme could not be answered.
- For Level 1 part 2: Time out of range (in %), but it is common practice to work with time out of range in hours in Denmark (hr). Confusing arises when units are converted.
- EN 16798 was not able to find.

- The Danish Building Regulations do not set special requirements for a renovation. However, for new buildings of dwellings, there are requirements for excess temperatures. Due to the size of the renovation case indoor climate simulations has been performed to investigate temperature conditions etc. Thus, it has been possible to obtain data for this macro objective. For smaller cases, it is doubtful whether indoor climate simulations will be carried out. Thus many inputs would not be obtained.

Accessibility to data, tools and standards

The table below focuses on whether or not the participants have used additional tools, datasets or references. As shown in Table 86, about half of the respondents have used additional tools etc. in order to fulfil the task.

TABLE 86. Use of other references, datasets or tools

Q4.	Yes	No
When making the assessment, were there any other specific references, datasets or tools you had used on other building assessments that proved useful?	9	7

Note: 16 out of 18 projects answered.

The respondents were asked to provide information on which tools, datasets or references they used when making the assessments. The following tools, references or datasets from previous projects were used:

- DGNB certification, in particular, SOC 1.1.
- BSim.
- IDA Indoor Climate and Environment.
- IES-VE.

The respondents were asked about their access to required results from other assessments of the building. The responses in Table 87 below show that the majority of respondents to a varying degree had access to data from other assessments of the building.

TABLE 87. Access to previous assessments

Q5	Not at all	Limited extent	Moderate extent	Great extent	Very great extent
To what extent did you already have access to the required results from other assessments of the building?	0	3	3	6	3

Note: 15 out of 18 projects answered.

Furthermore, the respondents were asked to identify the sources of results which were available. The main sources are listed below:

- DGNB SOC 1.1 measurements/calculations.
- BSim calculations.
- EN16798.
- Be18 (SBi Directions 213).

Table 88 below illustrates the availability of standards, tools and references when making the assessments. The majority of respondents had already access to the additional sources. However, it has not been possible for a significant part of the respondents to obtain technical standards used in Level(s).

TABLE 88. Availability of standards, data and/or tools

Q6.If you had to obtain the standards, data and /or tools in order to make the Level(s) assessment, how readily available were they?						
Please answer for each of the following aspects	Not possible to obtain	Difficult to obtain	Some effort to obtain	Easy to obtain	Already had them	*Not relevant to this test building*
6.1 The technical standards used	7	0	0	3	6	0
6.2 The databases used	2	0	3	2	6	3
6.3 Calculation and modelling tools	3	0	2	3	8	0

Note: 16 out of 18 projects answered.

The following Table 89 focuses on whether the cost of the additional sources has been a barrier to using them. Half of the respondents do not consider the cost of additional sources to be a barrier for using them, while the other half consider costs to be a barrier to some extent.

TABLE 89. Cost as barrier

Q7. If you had to purchase the standards, data and/or tools, to what extent was their cost a barrier to using them?			
Please answer for each of the following aspects	Not at all	One of the factors	The main factor
7.1 The technical standards used	7	5	2
7.2 The databases used	8	4	2
7.3 Calculation and modelling tools	7	2	5

Note: 14 out of 18 projects answered.

Competences

Previous experience of the respondents with of using life cycle tool with regard to time out of thermal range is summarised in Table 90 below. The respondents have some or extensive experience with using this indicator.

TABLE 90. Previous experience with similar indicators or tools

Q8.	No previous experience	Limited previous experience	Some previous experience	Extensive previous experience
How would you describe the previous experience of the test team with similar indicators or life cycle tools?	1	2	5	7

Note: 15 out of 18 projects answered.

Based on their previous experiences in the area, the respondents have indicated that no or limited additional training is necessary to use the indicator or the life cycle tool. Their responses are summarised in the following Table 91.

TABLE 91. Need for additional training

Q9.1	Not at all	Limited extent	Moderate extent	Great extent	Very great extent
Based on the previous experience of the test team, to what extent did using this indicator or life cycle tool require additional training and support?	7	7	1	0	1

Note: 16 out of 18 projects answered.

Furthermore, the respondents were asked to elaborate on the type of training, which is required in order to use the indicator or life cycle tool as intended. Their responses are summarised in Table 92 below.

TABLE 92. Areas of additional training

Q9.2	Knowledge of standards or methods	Calculation or modelling tool software use	Access to and handling of data sets	Other (please specify)
If additional training and support was required, please identify the main areas where it was necessary	6	5	3	0

Note: 14 out of 18 projects answered.

According to the table above additional training is required in two main areas:

- Knowledge of standards or methods.
- Calculation or modelling tool software use.

The respondents identified a number of other areas where additional training is required:

- In order to define ranges etc. for compliance with EN 16798, the standard had to be studied.
- Weather data in BSim.
- This indicator requires measurements in order to get the desired results. However, this measurement cannot be carried out by me as it requires specific knowledge on the topic. In case that only the EN ISO standards applied knowledge on how to use them in order to proceed in further calculations is required as well.
- Knowledge of EN16798 is needed.
- The exercise with calculating with and without heating/cooling is a new working method in Denmark.
- The EN16798 is missing.
- An expert is needed to conduct the calculations, but it is normally conducted already at early design stages due to common practice and building regulations.

Table 93 gives an overview of the estimated costs in man days for fulfilling the requirement for this particular indicator or tool. More than one-third of the respondents have not replied, about one-third have spent a day or less, and a smaller group has spent 2 or more days.

TABLE 93. Estimated time consumption in man days

Q10.1 If possible please provide an estimate of the cost and/or time that were required to use this indicator or tool.	No response	0.5	1	2	4
	7	4	5	1	1

Table 94 gives an overview of the estimated costs in Euros for fulfilling the requirement for this particular indicator or tool. Half of the respondents have not answered the question. The responses cover a very wide range all the way from EUR40 to EUR25,000 with an average around EUR1,000.

TABLE 94. Estimated cost in Euros

Q10.2 If possible please provide an estimate of the cost and/or time that were required to use this indicator or tool.	No response	100	450	650	800	1,000	1,920	7,000
	9	1	1	1	1	3	1	1

Suggestions for improvement

The respondents were asked to make any suggestions for improvements that would make it easier to use the indicator. The following suggestions were made:

- If possible, make it more compliant with national compliance methods. However for the sake of international benchmarking it makes sense to use a specific EN standard in Level(s).
- In part 1, the dropdown menu for "EN standard" is placed outside the box. Most often, I do not work with hours outside the range for temperature defined as a percentage (%). I have only worked with hours (h). In Denmark, we do not work without heating! (I have never worked with a building without heating). Thereby it is difficult to set a range without. Is it to examine the performance of the building without any input from cooling and heating? There is an error in Rating 1 of the tool. Nothing fits the description in the part. In 4.2 in the table regarding “Part 1 – EN standard compliant….” – the scroll down menu is outside the table. In 4.2 in the table for “reliability rating of the performance” – there is an incorrect text. The ratings are handling water and water consumption regarding fittings amongst others. However this is not what the macro objective is handling, and not the information given in the manual part 3. In 4.2 you shall describe if “Energy Performance of Buildings assessment sub-type is design/as-build or standard” – but there is no description of what is meant with “standard”?
- It was not possible for us to carry out this assessment as no one had done it previously and we did not have the information or the qualifications to make it.
- Fairly simple.
- National standard for Level(s). Level(s) needs to be more simple. The manual is way too technical and should be in less pages. There should be some benchmarks for each level.
- The reporting tool is quite simple and easy to understand. However the calculations behind need some specific expertise. Thus, I would recommend to provide more detailed instructions on how to implement ISO standards (there is limited access) and recommend a calculation tool as well. A feedback on the performance and validity of the assessment would be useful as well.
- There is a difference between southern and northern Europa regarding the temperatures in summer and winter. These differences should be taken into account. E.g. it is not realistic to simulate indoor thermal climate without heating in the winter in Denmark.
- More space to report results when there has been made simulation of more than one room (different calculations tools -> different results). Different options for answers for countries from north and south.
- A lot of the information / criteria are similar to the requirements from e.g. BR18, and it is thus not causing additional work to conduct this indicator for a common Danish building

project. The Post-occupancy assessment (optional) can be time consuming and is not a requirement in BR or DGNB and therefore more advanced to perform.

- I lack a possible differentiation compared to the size of the renovation case. For major renovations, it would be possible to carry out studies with regard to indoor climate, where, to a lesser extent, there is no requirement for it and will probably not be carried out (also by type of renovation). Therefore, it would be good with some more general criteria that can also be used on minor renovations. However, I think it is a quality to look at indoor climate also for renovation cases, as today there are no requirements for this.

The value of using Level 2 and Level 3

For this indicator, 4 projects reported on Level 2 and 5 projects on Level 3. The majority of the 8 responses consider the value of using Level 2 to be either limited or uncertain, although 2 respondents consider it to be useful to a moderate or very great extent (Table 95).

TABLE 95. The value of using Level 2

	Not at all	Limited extent	Moderate extent	Great extent	Very great extent	Not sure
Q12.1 To what extent did Level 2 prove to be useful in making comparisons between buildings?		3	1		1	3

Note. Responses: 8/18 – 4 projects reported on Level 2

With regard to the usefulness of applying Level 2 the respondents added the following comments:

- Not used, but the intention and described method seems good and useful.
- Not relevant in this case, but benefit of comparative performance assessments is seen in other projects, hence the indicator could help push the agenda.

The majority of the 9 answers regarding the use of Level 3 display that the effect is assessed as uncertain or limited except for 2 responses indicating that the value may be moderate or great (Table 96).

TABLE 96. The value of using Level 3

	Not at all	Limited extent	Moderate extent	Great extent	Very great extent	Not sure
Q13.2 To what extent did Level 3 prove useful in obt aining more precise and reliable results?		1	1	1		6

Note. Responses 9/18 – 5 projects reported on Level 3

No additional comments were received.

Summary

With regard to the applicability of this indicator on time out of thermal range, the major part of respondents finds the indicator logical and easy to use to a moderate extent. The main part of participants has responded that they have encountered problems to a moderate extent, whereas some have encountered problems to a great extent.

The responses from this section in relation to problems encountered can be mainly categorized as lack of access to the standard (e.g. EN16798) and obtaining results from the indicator and establishing the data.

With regard to accessibility of data, tools etc., the participants have mainly used the following tools, datasets or reference in previous projects: DGNB certification, the standard EN 16798 and the simulation tools BSim and IDA Indoor Climate and Energy.

With regard to competences, the participants had some or extensive previous experience with similar tools, hence a significant part of the participants do not require additional training at all, whereas a considerable part of the participant require additional training only to a limited extent. They mainly identified knowledge of standards and access to the dataset as the main areas where additional training was required.

6.2 Recommended in addition to the minimum scope

6.2.1 Indicator 1.2: Life Cycle Global Warming Potential (GWP)

The indicator focus on the global warming potential throughout the life cycle of the building. GWP is one environmental impact category that is calculated when Life cycle assessment (LCA) of building is carried out. The setting of the system boundaries in Level(s) shall follow the 'modularity principle' according to the EN 15978 standard for environmental assessment of buildings life cycle. Level(s) offers some simplified options by modelling some selected life cycle stages.

TABLE 97. Distribution on Level(s) reporting requirements

	Level 1	Level 2	Level 3
1.2 Life cycle Global Warming Potential (GWP)	3	4	1

Applicability and ease of use

This section of the survey focuses on Life Cycle Global Warming Potential (GWP). Three projects reported on Level 1, four on Level 2 and one on Level 3 for this indicator. It has to be kept in mind when looking at the results of the survey that half of the projects (9/18) did not report on this indicator.

Based on their experience with the indicator, the respondents were asked to evaluate whether the indicator was logical and easy to use. Specifically, the participants responded to the following question:

"To what extent was the indicator or life cycle tool easy and logical to use?"

The question above consisted of seven sub-questions, which the participants were asked to respond to. Their responses are summarised in the following table.

TABLE 98. Ease of use – indicator for Life Cycle Global Warming Potential (GWP)

Q1. To what extent was the indicator or life cycle tool easy and logical to use?	Not at all	Limited extent	Moderate extent	Great extent	Very great extent	Not relevant to this test
1.1 The guidance for making a common performance assessment provided in the JRC Level(s) documentation	0	3	3	2	0	1
1.2 The calculation method(s) and standards that are specified should be used	0	2	4	2	0	1
1.3 The unit of measurement that is specified should be used	0	0	2	6	0	1
1.4 The reporting format that is provided in the documentation	0	2	5	0	0	1
1.5 The suggested calculation tools and reference data sources	0	0	6	2	0	1
1.6 If used, the Level 2 rules for comparative reporting	0	0	1	4	0	2
1.7 If used, the Level 3 aspects and guidance notes	0	0	0	0	0	7

Note. Projects reported on this indicator: 8/18 - No response from 9/18.

Table 99 illustrates that for most of the aspects asked regarding satisfaction distributes around moderate extent, and with no answers for “not at all” and “very great extent”. The satisfaction is a bit less with the guidance given and a bit higher with the unit chosen.

For this indicator, four projects reported on Level 2 and one project on Level 3. When The responses on if the Level 2 rules for comparative reporting were easy and logical to use were four on great extent and one on moderate extent. No answers were given on Level 3, although one project reported on Level 3.

The participants were asked to reflect on to what extent the indicator helped them to make a comparison of different building designs. Their responses are shown in Table 99 below.

TABLE 99. Supporting comparison of alternative design options

	Not at all	Limited extent	Moderate extent	Great extent	Very great extent	Not sure
Q2. If comparisons were made of different buildin g design options, to what extent did the indicator or life cycle tool help to do this?	0	0	0	0	0	5

Note. Projects reported on this indicator: 8/18 - No response from 13/18.

Subsequently, the participants were asked to reflect, to what extent whether they encountered any issues in obtaining the results for the indicator or life cycle tool. Their responses are summarised in Table 100.

TABLE 100. Extent of problems obtaining results

	Not at all	Limited extent	Moderat e extent	Great extent	Very great extent
Q3. To what extent did you encounter any problems in obtai ning a result for the indicator or life cycle tool?	1	1	4	2	0

Note. Projects reported on this indicator: 8/18 - No response from 10/18.

The results summarized in Table 100 above shows that 2/8 projects working with this indicator encountered no problems or in a limited extent in obtaining a result for the indicator, 4/8 had problems in moderate extent and 2/8 in great extent. The type of problems mentioned was:

- The lifecyde tools used for this indicator, did not provide with all the data. Instead an assumption was made that all could be entered in one scenario GWH-GHGS (1+2)
- We were not able to split the values into biogenic and fossil, and teh the value for land use. The tool used does not calculate stage (D)
- Additional remark: The LCA was not used as a design tool, but the potential to use it to explore different design options is considered high.
- There are several values required in this indicator that cannot be obtained from an LCAbyg analysis or DGNB's LCA spreadsheet.
- The data gathering is the largest barrier. e.g. 3D models are often not modelled correctly to retrieve data, it is thus essential to be involved at a very early stage to ensure the right data can be gathered without extra cost. Final documentation can be gathered from the contractors and can also be very time consuming as it may be based on manual input.
- Additional remark: The LCA was not used as a design tool, but the potential to use it to explore different design options is considered high.
- The project was DGNB certified hence an LCA was conducted in accordance with DGNB. It would be good if the reporting tool could ask the methodological questions like what life cycle modules where calculated and what service life etc. and especially with a renovation project it would be important to state what building elements were reused (e.g. only modules B and C would be accounted for for theese) and which building elements were added (including all life cycle modules). It would be good with a guidance for renovation projects as the Danish LCA for renovations conducted by SBi."

Accessibility to data, tools and standards

The respondents were asked to specify whether they had used other tools, datasets or references when making the assessments. The responses are summarized as in the table below.

TABLE 101. Use of other references, datasets or tools

	Yes	No
Q4. When making the assessment, were there any other specific references, datasets or tools you had used on other building assessments that proved useful?	5	3

Note. Projects reported on this indicator: 8/18 - No response from 10/18.

In supplementary comments, the respondents referred to the following tools and methods that were useful:

- DGNB works with an LCA-excel tool. It is also possible in DK to use a program called "LCA-byg" developed by the Danish Building Research Institute.
- GaBi software for life cycle assessment and EN 15978.

The table below summarises their access to the required results from other previous assessments of the building.

TABLE 102. Access to previous assessments

	Not at all	Limited extent	Moderate extent	Great extent	Very great extent
Q5. To what extent did you already have access to the required results from other assessments of the building?	1	1	3	0	3

Note. Projects reported on this indicator: 8/18 - No response from 10/18.

The participants identified the following sources of results, which were either available already or diverged from Level(s).

- LCA Byg
- DGNB LCA spreadsheet
- A LCA had already been made for the project. Otherwise, the work would have been much more time-consuming.
- A whole life cycle assessment was conducted for the project, where GWP was one of the impact categories. Energy calculations according with the Danish national building regulation was conducted as well and used for the use phase
- Already had the BoM and weight of all inputs and outputs during construction stage

The participants were ask to respond to how available standards, tools or data were. The following Table 103 summarises the responses received.

TABLE 103. Availability of standards, data and/or tools

Q6.If you had to obtain the standards, data and/or tools in order to make the Level(s) assessment, how readily available were they?						
Please answer for each of the following aspects	Not possible to obtain	Difficult to obtain	Some effort to obtain	Easy to obtain	Already had them	*Not relevant to this test building*
6.1 The technical standards used	0	0	0	2	5	1
6.2 The databases used	0	0	0	2	6	0
6.3 Calculation and modelling tools	0	0	0	2	6	0

Note. Projects reported on this indicator: 8/18 - No response from 10/18.

According to table 103 above, the project participants state that the already have (or it would be easy to obtain) technical standards, databases and calculation and modelling tools for this indicator.

According to table 104 purchasing databases or calculation and modelling tools is not assumed to be a cost barrier by the majority of the projects.

TABEL 104. Cost as barrier

Q7. If you had to purchase the standards, data and/or tools, to what extent was their cost a barrier to using them?			
Please answer for each of the following aspects	Not at all	One of the factors	The main factor
7.1 The technical standards used	6	1	0
7.2 The databases used	6	1	0
7.3 Calculation and modelling tools	7	0	0

Note. Projects reported on this indicator: 8/18 - No response from 11/18.

Competences

The participants were asked to describe the previous experience of the test team with a similar indicator or life cycle tools. Their answers are summarised in Table 105 below.

TABLE 105. Previous experience with similar indicators or tools

Q8.	No previous experience	Limited previous experience	Some previous experience	Extensive previous experience
How would you describe the previous experience of th e test team with similar indicators or life cycle tools?	0	4	1	3

Note. Projects reported on this indicator: 8/18 - No response from 10/18.

According to the table above, half of the projects (4/8) did have limited previous experience with the indicator and life cycle tools while the other half had some and extensive experience.

Taking their previous experience into account, the respondents were asked to respond to the question about whether the use of the indicator required additional training and support. Their responses are summarised in the following Table 106.

TABLE 106. Need for additional training

Q9.1	Not at all	Limited extent	Moderat e extent	Great extent	Very great extent
Based on the previous experience of the test team, to what extent did using this indicator or life cycle tool require additional training and support?	4	1	3	0	0

Note. Projects reported on this indicator: 8/18 - No response from 10/18.

Half of the participant answered that the work with the indicator did not require additional training and support, while the other half needed that in limited to a moderate extent.

Furthermore, the respondents were asked to elaborate on the type of training, which is required in order to use the indicator or life cycle tool as intended. Their responses are summarised in Table 107 below.

TABLE 107. Areas of additional training

Q9.2	Knowledge of standards or methods	Calculation or modelling tool software use	Access to and handling of data sets	Other (please specify)
If additional training and support was required, please identify the main areas where it was necessary	2	2	2	1

Note. Projects reported on this indicator: 8/18 - No response from 11/18.

According to the table above the suggestions were evenly spread out between standards, calculation tool and data. The respondents further identified the type of training and/or support that was needed:

- It is important that an expert conduct the assessment. The expert must understand the specific Level(s) requirements regarding scope e.g. service life and life cycle modules etc.

Table 108 gives an overview of the estimated costs in man days fulfilling the requirement for this particular indicator or tool. About two-third of the respondents have not replied, less than one-third have spent a day or less, and most responsondense have spent 5 or more days. It is not clear whether the last group of answers is effectively covering the entire test or just this indicator tool.

TABLE 108. Estimated time consumption in man days

Q10.1 If possible please provide an estimate of the cost and/or time that were required to use this indicator or tool.	No response	0.1	0.25	5	7	10
	11	1	1	1	2	2

Table 109 gives an overview of the estimated costs in Euros for fulfilling the requirements for the particular indicator or tool. More than two-thirds of the respondents have not answered the question. The ones responding on the estimated costs indicate a very wide range of the estimated costs (from EUR20 to EUR10,000).

TABLE 109. Estimated cost in Euros

Q10.2 If possible please provide an estimate of the cost and/or time that were required to use this indicator or tool.	No response	20	5,000	10,000
	14	1	1	2

Suggestions for improvement

The participants were asked to make suggestions for improvements of the indicator that would make it easier to use. The following suggestions were received:

- Adjustments that makes it possible for Danish projects to report.
- Simplify the report for better comprehension of the indicator and reporting needed in the tool."
- The differences in calculation methods could be more easily shown or filled into some kind of form, regarding the scope covered, etc.
- For the LCA to be comparable it is necessary to know exactly which life cycle stages has been included. e.g. if one project reports use phase B1-7 with only replacement or A4-5 with only transport, this must be described.
- If the test of Level(s) is based on DGNB material from a finished project, the highest level possible to report on, is level 2.
- Working with level 3 - it is essential that the construction process stage is reported and documented from the beginning of the project (Level 3 sets higher requirements than DGNB)"
- Simple guidance, examples, webinars with publication of the indicator, formulas, 100% application of the method according to harmonized standards. Loose redundant text that does not add value or knowledge to the practitioner.
- It is important that the indicator is adapted so that the data that can be obtained through a Danish LCA analysis can be used in Level(s). If not, there should be a better explanation of where and how to enter the data that can be obtained from the analysis. It should also be better informed what is included in the LCA analysis. For our project (a renovation project), we have only evaluated the materials that are being rebuilt in the

project, and so no materials are being torn down or left standing. It is uncertain what is required in Level(s) assessment when doing LCA in a renovation project.
- For this to be used for renovation projects it is essential that a guideline for this is available.

The value of using Level 2 and Level 3

For this indicator, four projects reported on Level 2 and one project on Level 3. Four projects reported on Level 2 and one project on Level 3.

TABLE 110. The value of using Level 2

	Not at all	Limited extent	Moderate extent	Great extent	Very great extent	Not sure
Q12.1 To what extent did Level 2 prove to be useful in making comparisons between buildings?	3	1	0	2	0	0

Note. Projects reported on this indicator: 8/18 - No response from 12/18.

If the value of using Level 2 was moderate or higher, the participants were asked to reflect on how its use influenced the results. Six projects replied on this question, while only four projects reported on the indicator. Out of those six replies, two projects reported that Level 2 proved to be a useful great extent, while three projects reported not at all.

The following comments were received:

- It was not used for this specific project, but for other projects it has proven useful to compare different solutions on the related environmental impact.
- Because we had already made a DGNB pre-certification for our project, Level 2 was already been completed. Thus, it did not require any further to achieve this level

TABLE 111. The value of using Level 3

	Not at all	Limited extent	Moderate extent	Great extent	Very great extent	Not sure
Q13.2 To what extent did Level 3 prove useful in obt aining more precise and reliable results?	0	1	0	0	0	3

Note. Projects reported on this indicator: 8/18 - No response from 14/18.

There was only one project that reported on Level 3, and here it was reported by one project that Level 3 did only in limited extent prove to be useful in obtaining more precise and reliable results.

- This level was not evaluated but from experience with LCAs in general, it is very important to have transparent methods and tools that support precise and reliable results. It is a very welcome "indicator" and will be very important for the future of LCAs to enhance transparency and reliability.

Summary

The indicator was only tested in about half of the projects. Most of the project teams found working with the indicator easy and logical to use in moderate extent, both regarding the calculation method, unit chosen, reporting format and the suggested calculation tools and reference data sources. About half of the projects encountered problems in moderate extent when working with the indicator while the other half did either encounter problems in a limited amount or in a great amount. About half (5/8) had worked with this indicator before

in DGNB certification and had used the LCA tools developed in Denmark for this purpose. Thus about half of the participants had some or extensive previous experience with working with this indicator while the other half had limited experience. Same applied for the training needed, half did not need additional training while the other half needed it in limited or moderate extent. The system boundaries and options for simplification offered in Level(s) resulted in contradictions with the system boundaries in the Danish LCA tools, and the participants suggested that this should be improved.

6.2.2 Indicator 2.1: Building Bill of Materials (BoM)

This indicator focus on the compilation of data on what the building is composed of, using the Bill of Quantities as a starting point. This exercise provides the raw data for indicators such as 1.2 in order to calculate environmental impacts. The Bill of Quantities (BoQ) is the starting point for compiling a Bill of Materials (BoM). A BoQ specifies the quantities of different elements of a building (e.g. foundations, columns), as well as their technical specifications and expected lifetime. The BoQ comprises different categories of elements, which can have different functional performance characteristics. A Bill of Materials (BoM) describes the materials contained in the building's elements (e.g. concrete, steel, aluminium). The Bill of Materials includes an accounting of four groups of materials which are: Metals, Non-metallic mineral materials, Fossil energy materials and Biomass-based materials.

TABLE 112. Distribution on Level(s) reporting requirements

	Level 1	Level 2	Level 3
2.2 Life cycle tool: scenario 1 - Building and elemental service life planning	2	2	

Applicability and ease of use

This section of the survey focuses on Building Bill of Materials (BoM). In total, only four projects out of 18 tested this indicator, where one project reported on Level 1, two projects on Level 2 and one project on Level 3.

Based on their experience with the indicator, the respondents were asked to evaluate whether the indicator was logical and easy to use. Specifically, the participants responded to the following question:

"To what extent was the indicator or life cycle tool easy and logical to use?"

The question above consisted of seven sub-questions, which the participants were asked to respond to. Their responses are summarised in the following table.

TABLE 113. Ease of use – indicator for Building Bill of Materials (BoM)

Q1. To what extent was the indicator or life cyc le tool easy and logical to use?	Not at all	Limited extent	Moderate extent	Great extent	Very great extent	Not relevant to this test
1.1 The guidance for making a common performance assessment provided in the JRC Level(s) documentation	0	0	1	3	0	2
1.2 The calculation method(s) and standards that are specified should be used	0	1	3	0	0	2
1.3 The unit of measurement that is specified should be used	0	1	0	1	2	2
1.4 The reporting format that is provided in the documentation	0	1	0	3	0	2
1.5 The suggested calculation tools and reference data sources	0	0	2	2	0	2
1.6 If used, the Level 2 rules for comparative reporting	0	1	0	0	0	0
1.7 If used, the Level 3 aspects and guidance notes	2	1	2	0	0	0

Note. Projects reported on this indicator: 4/18 - No response from 12/18.

The participants were asked to reflect on to what extent the indicator helped them to make a comparison of different building designs. No answers were received, as can be seen in table 114 below.

TABLE 114. Supporting comparison of alternative design options

	Not at all	Limited extent	Moderate extent	Great extent	Very great extent	Not sure
Q2. If comparisons were made of different buildin g design options, to what extent did the indicator or life cycle tool help to do this?	0	0	0	0	0	0

Note. Projects reported on this indicator: 4/18 - No response from 18/18.

Subsequently, the participants were asked to reflect, to what extent whether they encountered any issues in obtaining the results for the indicator or life cycle tool. No answers were received, as can be seen in Table 115 below.

TABLE 115. Extent of problems obtaining results

	Not at all	Limited extent	Moderat e extent	Great extent	Very great extent
Q3. To what extent did you encounter any problems in obtai ning a result for the indicator or life cycle tool?	0	0	0	0	0

Note. Projects reported on this indicator: 4/18 - No response from 18/18.

One project commented that:

- Data of materials from LCA/LCC were used.

Accessibility to data, tools and standards

The respondents were asked to specify whether they had used other tools, datasets or references when making the assessments. No answers were received, as can be seen in Table 116 below.

TABLE 116. Use of other references, datasets or tools

	Yes	No
Q4. When making the assessment, were there any other specific references, datasets or tools you had used on other building assessments that proved useful?	0	0

Note. Projects reported on this indicator: 4/18 - No response from 18/18.

In supplementary comments, the respondents referred to the following tools and methods that were useful:

- LCA- and LCC-calculations incl. Building component libraries. (This was only available as the project was DGNB project, and might have been difficult to retrieve from other building projects.).

The table below summarises their access to the required results from other previous assessments of the building.

TABLE 117. Access to previous assessments

	Not at all	Limited extent	Moderate extent	Great extent	Very great extent
Q5. To what extent did you already have access to the required results from other assessments of the building?	0	0	0	0	0

Note. Projects reported on this indicator: 4/18 - No response from 18/18.

The participants expressed in additional comments that the required data and results were easy to obtain:

- Already had them
- Easy to obtain

The participants were ask to respond to how available standards, tools or data were. The following Table 118 summarises the responses received.

TABLE 118. Availability of standards, data and/or tools

Q6.If you had to obtain the standards, data and/or tools in order to make the Level(s) assessment, how readily available were they?						
Please answer for each of the following aspects	Not possible to obtain	Difficult to obtain	Some effort to obtain	Easy to obtain	Already had them	*Not relevant to this test building*
6.1 The technical standards used	0	0	0	0	3	2
6.2 The databases used	0	0	0	0	0	0
6.3 Calculation and modelling tools	0	0	0	0	0	0

Note. Projects reported on this indicator: 4/18 - No response from 13/18.

According to Table 118 above, three projects identified that they already had the technical standards for this indicator.

According to Table 119, purchasing technical standards or calculation and modelling tools is not assumed to be a cost barrier by the few projects that responded to this question.

TABLE 119. Cost as barrier

Q7. If you had to purchase the standards, data and/or tools, to what extent was their cost a barrier to using them?			
Please answer for each of the following aspects	Not at all	One of the factors	The main factor
7.1 The technical standards used	3	0	0
7.2 The databases used	0	0	0
7.3 Calculation and modelling tools	2	0	0

Note. Projects reported on this indicator: 4/18 - No response from 15/18.

Competences

The participants were asked to describe the previous experience of the test team with a similar indicator or life cycle tools. Their answers are summarised in Table 120 below.

TABLE 120. Previous experience with similar indicators or tools

Q8.	No previous experience	Limited previous experience	Some previous experience	Extensive previous experience
How would you describe the previous experience of th e test team with similar indicators or life cycle tools?	0	0	0	0

Note. Projects reported on this indicator: 8/18 - No response from 10/18.

According to the table above, half of the projects (4/8) did have limited previous experience with the indicator and life cycle tools while the other half had some and extensive experience.

Taking their previous experience into account, the respondents were asked to respond to the question about whether the use of the indicator required additional training and support. No responses were received as can be seen in Table 121.

TABLE 121. Need for additional training

Q9.1	Not at all	Limited extent	Moderat e extent	Great extent	Very great extent
Based on the previous experience of the test team, to what extent did using this indicator or life cycle tool require additional training and support?	0	0	0	0	0

Note. Projects reported on this indicator: 4/18 - No response from 18/18.

Furthermore, the respondents were asked to elaborate on the type of training, which is required in order to use the indicator or life cycle tool as intended. No responses were received, as can be seen in Table 122.

TABLE 122. Areas of additional training

Q9.2	Knowledge of standards or methods	Calculation or modelling tool software use	Access to and handling of data sets	Other (please specify)
If additional training and support was required, please identify the main areas where it was necessary	0	0	0	0

Note. Projects reported on this indicator: 4/18 - No response from 18/18.

Table 123 gives an overview of the estimated costs in man days fulfilling the requirement for this particular indicator or tool. More than two-third of the respondents have not replied. The ones replying have used half a day to two days on this indicator.

TABLE 123. Estimated time consumption in man days

Q10.1 If possible please provide an estimate of the cost and/or time that were required to use this indicator or tool.	No response	0.5	1	2
	14	1	2	1

Table 124 gives an overview of the estimated costs in Euros for fulfilling the requirements for the particular indicator or tool. Only three have answered the question, and here again, the responses indicate a very wide in the estimated costs (from EUR100 to EUR1,000).

TABLE 124. Estimated cost in Euros

Q10.2 If possible please provide an estimate of the cost and/or time that were required to use this indicator or tool.	No response	100	1,000
	15	1	2

Summary

This indicator was only tested in four projects and their answers on the easiness of the use of the indicator varied. There were also relatively few answers given by the participants on the different questions in the questionnaire. The ones answering reported that the data was relatively easy to obtain, that the already had the information through LCA and LCC calculations already performed in the projects.

6.3 Optional additional reporting

6.3.1 Life cycle tool 2.2: scenario 1 - Building and elemental service life planning

The aim of this indicator is to encourage a medium to long term focus on the design life of major building elements, as well as their associated maintenance and replacement cycles. The indicator includes estimation of the service life for the entire building and for major building elements (e.g. the envelope and structure).

TABLE 125. Distribution on Level(s) reporting requirements

	Level 1	Level 2	Level 3
2.2 Life cycle tool: scenario 1 - Building and elemental service life planning	2	2	

Applicability and ease of use

This section of the survey focuses on Building and elemental service life planning. Four projects in total reported on this indicator, two on Level 1 and two on Level 2.

Based on their experience with the indicator, the respondents were asked to evaluate whether the indicator was logical and easy to use. Specifically, the participants responded to the following question:

"To what extent was the indicator or life cycle tool easy and logical to use?"

The question above consisted of seven sub-questions, which the participants were asked to respond to. Their responses are summarised in the following table.

TABLE 126. Ease of use – indicator for Building and elemental service life planning

Q1. To what extent was the indicator or life cyc le tool easy and logical to use?	Not at all	Limited extent	Moderate extent	Great extent	Very great extent	Not relevant to this test
1.1 The guidance for making a common performance assessment provided in the JRC Level(s) documentation	0	0	1	3	0	1
1.2 The calculation method(s) and standards that are specified should be used	0	1	1	2	0	1
1.3 The unit of measurement that is specified should be used	0	1	0	3	0	1
1.4 The reporting format that is provided in the documentation	0	1	0	3	0	1
1.5 The suggested calculation tools and reference data sources	0	0	2	2	0	1
1.6 If used, the Level 2 rules for comparative reporting	0	0	0	0	0	4
1.7 If used, the Level 3 aspects and guidance notes	0	0	0	0	0	4

Note. Projects reported on this indicator: 4/18 - No response from 13/18.

The participants were asked to reflect on to what extent the indicator helped them to make a comparison of different building designs. Their responses are shown in Table 127 below.

TABLE 127. Supporting comparison of alternative design options

	Not at all	Limited extent	Moderate extent	Great extent	Very great extent	Not sure
Q2. If comparisons were made of different buildin g design options, to what extent did the indicator or life cycle tool help to do this?	0	0	0	0	0	2

Note. Projects reported on this indicator 4/18 - No response from 13/18.

Subsequently, the participants were asked to reflect, to what extent whether they encountered any issues in obtaining the results for the indicator or life cycle tool. Their responses are summarised in Table 128.

TABLE 128. Extent of problems obtaining results

	Not at all	Limited extent	Moderat e extent	Great extent	Very great extent
Q3. To what extent did you encounter any problems in obtai ning a result for the indicator or life cycle tool?	2	0	1	1	0

Note. Projects reported on this indicator 4/18 - No response from 14/18.

The results summarized in Table 128 above shows that two projects working with this indicator encountered no problems, one in moderate extent and one in great extent.

Accessibility to data, tools and standards

The respondents were asked to specify whether they had used other tools, datasets or references when making the assessments. The responses are summarized as in the table below.

TABLE 129. Use of other references, datasets or tools

	Yes	No
Q4. When making the assessment, were there any other specific references, datasets or tools you had used on other building assessments that proved useful?	3	1

Note. Projects reported on this indicator 4/18 - No response from 14/18.

In supplementary comments, the respondents referred to the following tools and methods that were useful:

- The a) in the column “Data sources” refers to “Typical life span based on reported averages” in this case it is the LCA-tool used in the DGNB-certification which refers to the industry guidance SBi 2013:30

The table below summarises their access to the required results from other previous assessments of the building.

TABLE 130. Access to previous assessments

	Not at all	Limited extent	Moderate extent	Great extent	Very great extent
Q5. To what extent did you already have access to the required results from other assessments of the building?	0	1	1	0	2

Note. Projects reported on this indicator 4/18 - No response from 14/18.

The participants identified the following sources of results, which were either available already or diverged from Level(s).

- LCAbyg
- The required results for this MO were taken from the LCA-tool used in a DGNB.
- Record of replacements from the facility manager already. His professional testimony for the future replacements was considered too.

The participants were asked to respond to how available standards, tools or data were. The following Table 131 summarises the responses received.

TABLE 131. Availability of standards, data and/or tools

Q6.If you had to obtain the standards, data and/or tools in order to make the Level(s) assessment, how readily available were they?						
Please answer for each of the following aspects	Not possible to obtain	Difficult to obtain	Some effort to obtain	Easy to obtain	Already had them	*Not relevant to this test building*
6.1 The technical standards used	0	0	0	0	3	1
6.2 The databases used	0	0	0	0	3	1
6.3 Calculation and modelling tools	0	0	0	0	3	1

Note. Projects reported on this indicator 4/18 - No response from 14/18.

According to table 131 above, 3/4 of the project participants testing this indicator report that they already have technical standards, databases and calculation tools while ¼ report that these were not relevant.

According to Table 132, purchasing databases or calculation and modelling tools is not assumed to be a cost barrier by the three projects responding on this question.

TABLE 132. Cost as barrier

Q7. If you had to purchase the standards, data and/or tools, to what extent was their cost a barrier to using them?			
Please answer for each of the following aspects	Not at all	One of the factors	The main factor
7.1 The technical standards used	3	0	0
7.2 The databases used	3	0	0
7.3 Calculation and modelling tools	3	0	0

Note. Projects reported on this indicator 4/18 - No response from 15/18.

Competences

The participants were asked to describe the previous experience of the test team with a similar indicator or life cycle tools. Their answers are summarised in Table 133 below.

TABLE 133. Previous experience with similar indicators or tools

Q8.	No previous experience	Limited previous experience	Some previous experience	Extensive previous experience
How would you describe the previous experience of th e test team with similar indicators or life cycle tools?	0	1	1	2

Note. Projects reported on this indicator 4/18 - No response from 14/18.

According to the table above, the previous experience was very different from the participants reporting on this indicator.

Taking their previous experience into account, the respondents were asked to respond to the question about whether the use of the indicator required additional training and support. Their responses are summarised in the following Table 134.

TABLE 134. Need for additional training

Q9.1	Not at all	Limited extent	Moderat e extent	Great extent	Very great extent
Based on the previous experience of the test team, to what extent did using this indicator or life cycle tool require additional training and support?	3	1	0	0	0

Note. Projects reported on this indicator 4/18 - No response from 14/18.

The participants answered that the work with the indicator did not or in limited extent require additional training and support.

Furthermore, the respondents were asked to elaborate on the type of training, which is required in order to use the indicator or life cycle tool as intended. Their responses are summarised in Table 135 below. Only one answer was received.

TABLE 135. Areas of additional training

Q9.2	Knowledge of standards or methods	Calculation or modelling tool software use	Access to and handling of data sets	Other (please specify)
If additional training and support was required, please identify the main areas where it was necessary	0	0	1	0

Note. Projects reported on this indicator 4/18 - No response from 17/18.

Table 136 gives an overview of the estimated costs in man days fulfilling the requirement for this particular indicator or tool. More than two-third of the respondents have not replied, and the ones replying have spent half a day or less.

TABLE 136. Estimated time consumption in man days

Q10.1 If possible please provide an estimate of the cost and/or time that were required to use this indicator or tool.	No response	0.2	0.5	1.5
	14	1	2	1

Table 137 gives an overview of the estimated costs in Euros for fulfilling the requirements for the particular indicator or tool. More than two-third of the respondents have not answered the question. The three answers received indicate estimated costs in the range from EUR40 to EUR500.

TABLE 137. Estimated cost in Euros

Q10.2 If possible please provide an estimate of the cost and/or time that were required to use this indicator or tool.	No response	40	500
	15	1	2

Suggestions for improvement

The participants were asked to make suggestions for improvements of the indicator that would make it easier to use. The following suggestions were received:

- Needs to have a guide on how to address building elements consisting of materials with different lifespans.
- Easy to fulfill because: Life spans can be based on reported averages which can be found in the LCA or LCC calculations performed for the DGNB assessment or in the industry guide SBi 2013:30.
- Data is for building components, eg "ceilings" "external walls", "upper floors" and the lifetime must be for the whole building component and not at material level. Specification on how to account for the life span of a building component is missing. For example, it is not clear if the life span of a building component should be calculated as the lowest material life span in the component. Insulation and concrete, for example, do not have the same lifetime for an outer wall.
- It may have been easier to work from the various products, e.g. as defined in the LCA. Especially since lifetimes must be defined for the LCA anyways, to define the number of replacements.
- For an existing building, it may be easier anyways to report actual replacements instead of theoretical product life span data. Actual replacement data reveal performance in practice and real life spans. An extra column ‘maintenance’ may be useful, as replacements can be part of a maintenance activity. Life spans and durable performance are very important for the environmental performance, because of the direct consequences on the materials used in the life cycle, so we believe it is a methodological improvement to have a more detailed way of reporting which is better connected to practice."

The value of using Level 2 and Level 3

No answers were received and the tables are therefore left out.

Summary

The indicator was only tested by four projects. Of those four projects, the majority of the participants answered that they found the guidance, calculation methods, unit, reporting format and suggested calculation tool relatively easy to use. Half of the testing projects experienced no problems while the other half experienced problems in moderate and great extent. The participants that had experience with DGNB and using LCAbyg answered that they already had the tools needed and that they had the results needed from either DGNB and/or LCAbyg. Three of four teams did not need any additional training in order to work with the indicator, and one team did only need this in a limited extent.

6.3.2 Life cycle tool 2.2: scenario 2 - Design and adaptability and refurbishment

The aim of this indicator is to extend the service life of the building as a whole, either by facilitating the continuation of the intended use or through possible future changes in use. The indicator focuses on options to improve the performance of the building concerning life cycle stages B4 (Replacement) and B5 (Refurbishment). Through a checklist provided, the users shall identify design aspects implemented in the building design. The reporting diverges depending on whether the building is an office or residential:

- For offices, the checklist of design aspects focuses on flexibility within the office market, as well as the flexibility to change use within the property market.
- For residential properties, the checklist focuses on the potential to adapt to changing family and personal circumstances over time, as well as the flexibility to change use within the property market.

TABLE 138. Distribution on Level(s) reporting requirements

	Level 1	Level 2	Level 3
2.2 Life cycle tool: scenario 2 - Design for adaptability and refurbishment	4	2	

Applicability and ease of use

This section of the survey focuses on Design and adaptability and refurbishment. Four projects reported on Level 1 and two on Level 2. It has, therefore, to be kept in mind when looking at the results of the survey that half of the projects (12/18) did not report on this indicator.

Based on their experience with the indicator, the respondents were asked to evaluate whether the indicator was logical and easy to use. Specifically, the participants responded to the following question:

"To what extent was the indicator or life cycle tool easy and logical to use?"

The question above consisted of seven sub-questions, which the participants were asked to respond to. Their responses are summarised in the following table.

TABLE 139. Ease of use – indicator for Design and adaptability and refurbishment

Q1. To what extent was the indicator or life cycle tool easy and logical to use?	Not at all	Limited extent	Moderate extent	Great extent	Very great extent	Not relevant to this test
1.1 The guidance for making a common performance assessment provided in the JRC Level(s) documentation	0	2	2	1	0	1
1.2 The calculation method(s) and standards that are specified should be used	0	1	4	0	0	1
1.3 The unit of measurement that is specified should be used	0	0	1	2	0	3
1.4 The reporting format that is provided in the documentation	0	0	2	3	0	1
1.5 The suggested calculation tools and reference data sources	0	1	1	3	0	1
1.6 If used, the Level 2 rules for comparative reporting	0	0	0	3	0	2
1.7 If used, the Level 3 aspects and guidance notes	0	0	0	0	0	5

Note. Projects reported on this indicator: 6/18 - No response from 12/18.

It is difficult to draw conclusions from the answers received as relatively many answers are placed in “not relevant to this test” and the remaining answers are spread out in the options in the middle of the scale. No answers are given for “not at all” or “very great extent”.

The participants were asked to reflect on to what extent the indicator helped them to make a comparison of different building designs. Their responses are shown in Table 140 below.

TABLE 140. Supporting comparison of alternative design options

	Not at all	Limited extent	Moderate extent	Great extent	Very great extent	Not sure
Q2. If comparisons were made of different buildin g design options, to what extent did the indicator or life cycle tool help to do this?	1	1	0	0	0	2

Note. Projects reported on this indicator: 6/18 - No response from 14/18.

Subsequently, the participants were asked to reflect, to what extent whether they encountered any issues in obtaining the results for the indicator or life cycle tool. Their responses are summarised in Table 141.

TABLE 141. Extent of problems obtaining results

	Not at all	Limited extent	Moderat e extent	Great extent	Very great extent
Q3. To what extent did you encounter any problems in obtai ning a result for the indicator or life cycle tool?	0	4	0	1	0

Note. Projects reported on this indicator: 6/18 - No response from 13/18.

Five out of six projects working with this indicator replied to this question, where four of them experience no problems and one experienced problems in great extent.
One project working with a renovation case explained problems working with the indicator in renovation projects:

- As this is a renovation case, the relevance of working with the adaptability of the building is uncertain. The main grip for the building is fixed from the past and thus there is not much that can be changed. Thus, there is a problem in assessing this for renovation cases. The opportunity to assess the new part and focus on it should be created - is this flexible? With the existing, there is not much to do. For renovation it would be good to have a reference in relation to the existing building where it is assessed whether renovation is for the better or not.

Accessibility to data, tools and standards

The respondents were asked to specify whether they had used other tools, datasets or references when making the assessments. The responses are summarized as in the table below.

TABLE 142. Use of other references, datasets or tools

	Yes	No
Q4. When making the assessment, were there any other specific references, datasets or tools you had used on other building assessments that proved useful?	4	1

Note. Projects reported on this indicator: 6/18 - No response from 13/18.

In supplementary comments, the respondents referred to the following tools and methods that were useful:

- DGNB 2014 criteria: ECO2.1, TEC1.4

The table below summarises their access to the required results from other previous assessments of the building.

TABLE 143. Access to previous assessments

	Not at all	Limited extent	Moderate extent	Great extent	Very great extent
Q5. To what extent did you already have access to the required results from other assessments of the building?	0	0	3	2	0

Note. Projects reported on this indicator: 6/18 - No response from 13/18.

The participants identified the following sources of results, which were either available already or diverged from Level(s).

- DGNB criteria and LCA

The participants were asked to respond to how available standards, tools or data were. The following Table 144 summarises the responses received.

TABLE 144. Availability of standards, data and/or tools

Q6.If you had to obtain the standards, data and/or tools in order to make the Level(s) assessment, how readily available were they?						
Please answer for each of the following aspects	Not possible to obtain	Difficult to obtain	Some effort to obtain	Easy to obtain	Already had them	*Not relevant to this test building*
6.1 The technical standards used	0	0	0	0	4	1
6.2 The databases used	0	0	0	0	3	2
6.3 Calculation and modelling tools	0	0	2	0	1	2

Note. Projects reported on this indicator: 6/18 - No response from 13/18.

According to Table 144 above, the project participants already had the technical standards and databases used. The answers were more spread out for the calculation and modelling tools, where they either had to use some efforts to obtain them, they already had them or did not think they were relevant for this test.

The table below looks into the cost barrier related to purchasing standards, data and/or tools.

TABLE 145. Cost as barrier

Q7. If you had to purchase the standards, data and/or tools, to what extent was their cost a barrier to using them?			
Please answer for each of the following aspects	Not at all	One of the factors	The main factor
7.1 The technical standards used	2	3	0
7.2 The databases used	4	1	0
7.3 Calculation and modelling tools	2	1	2

Note. Projects reported on this indicator: 6/18 - No response from 13/18.

Competences

The participants were asked to describe the previous experience of the test team with a similar indicator or life cycle tools. Their answers are summarised in Table 146 below.

TABLE 146. Previous experience with similar indicators or tools

Q8.	No previous experience	Limited previous experience	Some previous experience	Extensive previous experience
How would you describe the previous experience of the test team with similar indicators or life cycle tools?	0	1	4	0

Note. Projects reported on this indicator: 6/18 - No response from 13/18.

According to the table above, four out of five projects responding to this question had some previous experience with the indicator and life cycle tools while one had limited experience.

Taking their previous experience into account, the respondents were asked to respond to the question about whether the use of the indicator required additional training and support. Their responses are summarised in the following Table 147.

TABLE 147. Need for additional training

Q9.1	Not at all	Limited extent	Moderate extent	Great extent	Very great extent
Based on the previous experience of the test team, to what extent did using this indicator or life cycle tool require additional training and support?	1	2	2	0	0

Note. Projects reported on this indicator: 6/18 - No response from 13/18.

The participants evaluated that the work with the indicator needed no to moderate additional training and support.

Furthermore, the respondents were asked to elaborate on the type of training, which is required in order to use the indicator or life cycle tool as intended. Their responses are summarised in Table 148 below.

TABLE 148. Areas of additional training

Q9.2	Knowledge of standards or methods	Calculation or modelling tool software use	Access to and handling of data sets	Other (please specify)
If additional training and support was required, please identify the main areas where it was necessary	1	0	1	2

Note. Projects reported on this indicator: 6/18 - No response from 11418.

According to the table above the suggestions were evenly spread out between standards, calculation tool and data. The respondents further identified the type of training and/or support that was needed:

- Market experts from local/regional market.

Table 149 gives an overview of the estimated costs in man days fulfilling the requirement for this particular indicator or tool. More than two-thirds of the respondents have not replied. The three participants replying have indicated a very wide range within the time spent on the indicator, from 0.1 day to four days.

TABLE 149. Estimated time consumption in man days

Q10.1 If possible please provide an estimate of the cost and/or time that were required to use this indicator or tool.	No response	0.1	1	4
	15	1	1	1

Table 150 gives an overview of the estimated costs in Euros for fulfilling the requirements for the particular indicator or tool. More than two-thirds of the respondents have not answered the question. The three answers received indicate estimated costs in the range from EUR20 to EUR4,000.

TABLE 150. Estimated cost in Euros

Q10.2 If possible please provide an estimate of the cost and/or time that were required to use this indicator or tool.	No response	20	800	4000
	15	1	1	1

Suggestions for improvement

The participants were asked to suggest improvements in the indicator that would make it easier to use.

The feedback from the two renovation projects differed. One project commented, “This indicator can easily be used for renovation projects”. The other project commented, “As a renovation case is built on an existing building, it is uncertain to what extent it is possible to look at the flexibility and adaptability of the building. The conditions are given and the structure of the building is not changed. Thus, it is unknown how this indicator can be used for a renovation case.

The value of using Level 2 and Level 3

For this indicator, four projects reported on Level 2 and one project on Level 3. Four projects reported on Level 2 and one project on Level 3.

TABLE 151. The value of using Level 2

	Not at all	Limited extent	Moderate extent	Great extent	Very great extent	Not sure
Q12.1 To what extent did Level 2 prove to be useful in making comparisons between buildings?	0	1	0	0	2	0

Note. Projects reported on this indicator: 6/18 - No response from 15/18.

If the value of using Level 2 was moderate or higher, the participants were asked to reflect on how its use influenced the results. Two projects worked with Level 2, however three projects answered to this question. Two projects found Level 2 useful in very great extent, while one project reported a limited extent. The following comments were received:

- "A numerical output is a good way to compare the performance of the building. OBS it needs to be for building using the same tool.
- If DGNB has been used earlier in the project, it is easy to do."

TABLE 152. The value of using Level 3

	Not at all	Limited extent	Moderate extent	Great extent	Very great extent	Not sure
Q13.2 To what extent did Level 3 prove useful in obt aining more precise and reliable results?	0	0	0	0	0	3

Note. Projects reported on this indicator: 6/18 - No response from 15/18.

No project reported on Level 3

- "Is not done because: a property market expert from the local/regional market shall identify; worst, intended and best-case scenarios for continued future use of the building. Or a software tool can be sued for analyzing building adaptability scenarios.
- LCA modelling for life cycle stage B5 (refurbishment)"

Summary

The life cycle tool was tested by six projects. The feedback on to what extent the life cycle tool was easy and logical to use was spread over the scale between “limited extent” to “great extent” and therefore difficult to draw any conclusions from the six projects. Four projects reported that they did not encounter any problems while one encountered problems in great extent. The life cycle tool is related to a DGNB criterion TEC 1.6 and projects also reported that this as relevant tools and access to data from previous assessments. The project teams had limited to some previous experience with working with similar requirements but reported that they needed no additional training or in limited to moderate extent.

6.3.3 Life cycle tool 2.2: scenario 3 - Design for deconstruction, reuse and recycling

The aim of the life cycle tool is to facilitate the future circular use of building elements, components and parts that make up a building’s material bank. The indicator focus on the potential for the reuse or recycling of major building elements following deconstruction. The scenario relates to the following life cycle stages and their associated modules:

- End of Life stage C1 (De-construction/demolition)
- End of Life stage C3 (Waste processing)
- Benefits beyond the system boundary D (Reuse/recycling/recovery potential).

TABLE 153. Distribution on Level(s) reporting requirements

	Level 1	Level 2	Level 3
2.2 Life cycle tool: scenario 3 - Design for deconstruction, reuse and recycling	5	2	

Applicability and ease of use

This section of the survey focuses on Design for deconstruction, reuse and recycling. Five projects reported on Level 1 and two on Level 2 for this indicator. It has, therefore, to be kept in mind when looking at the results of the survey that only seven out of 18 projects reported on this indicator.

Based on their experience with the indicator, the respondents were asked to evaluate whether the indicator was logical and easy to use. Specifically, the participants responded to the following question:

"To what extent was the indicator or life cycle tool easy and logical to use?"

The question above consisted of seven sub-questions, which the participants were asked to respond to. Their responses are summarised in the following table.

TABLE 154. Ease of use – indicator for 1.1.1 Design for deconstruction, reuse and recycling

Q1. To what extent was the indicator or life cy cle tool easy and logical to use?	Not at all	Limited extent	Moderate extent	Great extent	Very great extent	Not relevant to this test
1.1 The guidance for making a common performance assessment provided in the JRC Level(s) documentation	0	2	2	2	0	1
1.2 The calculation method(s) and standards that are specified should be used	0	2	1	2	0	2
1.3 The unit of measurement that is specified should be used	0	0	3	0	0	4
1.4 The reporting format that is provided in the documentation	0	1	2	3	0	1
1.5 The suggested calculation tools and reference data sources	0	0	3	2	0	2
1.6 If used, the Level 2 rules for comparative reporting	0	1	1	2	0	2
1.7 If used, the Level 3 aspects and guidance notes	0	0	0	0	0	6

Note. Projects reported on this indicator: 7/18 - No response from 12/18.

As with the previous indicator, it is also here difficult to draw conclusions from the answers received. Relatively many answers are placed in "not relevant to this test", but the remaining answers are spread out in the options in the middle of the scale. No answers are given for "not at all" or "very great extent".

The participants were asked to reflect on to what extent the indicator helped them to make a comparison of different building designs. Their responses are shown in Table 155 below.

TABLE 155. Supporting comparison of alternative design options

	Not at all	Limited extent	Moderate extent	Great extent	Very great extent	Not sure
Q2. If comparisons were made of different buildin g design options, to what extent did the indicator or life cycle tool help to do this?	0	0	0	0	0	4

Note. Projects reported on this indicator: 7/18 - No response from 14/18.

Subsequently, the participants were asked to reflect, to what extent whether they encountered any issues in obtaining the results for the indicator or life cycle tool. Their responses are summarised in Table 156.

TABLE 156. Extent of problems obtaining results

	Not at all	Limited extent	Moderat e extent	Great extent	Very great extent
Q3. To what extent did you encounter any problems in obtai ning a result for the indicator or life cycle tool?	1	2	1	2	0

Note. Projects reported on this indicator: 7/18 - No response from 12/18.

The results summarized in Table 156 above shows that the six projects responding to this question encountered problems in very different order of magnitude, all from no problems to problems in great extent. The type of problems mentioned was:
Unsure on how to obtain the correct or relevant results.

- It is difficult to report as the pre-defined disassembly aspects are not further defined. E.g. what is meant be disassembly? Can disassembly mean crushing and recycling concrete etc.
- Many of the required results were already obtained through a DGNB precertification. However, it is assumed that would require greater effort if this were to be done without a DGNB certification. In renovation cases, only the new part can be designed in terms of dismantling and recycling. The remaining part/not renovated part is not affected, and thus not how much of it can be recycled and sorted.

Accessibility to data, tools and standards

The respondents were asked to specify whether they had used other tools, datasets or references when making the assessments. The responses are summarized as in the table below.

TABLE 157. Use of other references, datasets or tools

	Yes	No
Q4. When making the assessment, were there any other specific references, datasets or tools you had used on other building assessments that proved useful?	4	2

Note. Projects reported on this indicator: 7/18 - No response from 12/18.

In supplementary comments, the respondents referred to the following tools and methods that were useful:

- DGNB 2014 criterion TEC1.6 & PRO1.3 and LCA

The table below summarises their access to the required results from other previous assessments of the building.

TABLE 158. Access to previous assessments

	Not at all	Limited extent	Moderate extent	Great extent	Very great extent
Q5. To what extent did you already have access to the required results from other assessments of the building?	0	2	3	1	0

Note. Projects reported on this indicator: 7/18 - No response from 12/18.

The participants identified the following sources of results, which were either available already or diverged from Level(s).

- As a part of the DGNB-work
- The building project already had an LCA and therefore EPD's
- Facility management
- DGNB pre-certification
- The building project already had an LCA and therefore EPD's or LCA data from Oekobau with end of life scenarios

The participants were asked to respond to how available standards, tools or data were. The following Table 159 summarises the responses received.

TABLE 159. Availability of standards, data and/or tools

Q6.If you had to obtain the standards, data and/or tools in order to make the Level(s) assessment, how readily available were they?						
Please answer for each of the following aspects	Not possible to obtain	Difficult to obtain	Some effort to obtain	Easy to obtain	Already had them	*Not relevant to this test building*
6.1 The technical standards used	0	0	1	2	2	1
6.2 The databases used	0	0	1	0	3	2
6.3 Calculation and modelling tools	0	0	1	0	3	2

Note. Projects reported on this indicator: 7/18 - No response from 12/18.

According to Table 159 above, the inmost cases project participants state that they already have (or it would be easy to obtain) technical standards, databases and calculation and modelling tools for this indicator.

According to Table 160, purchasing databases or calculation and modelling tools is not assumed to be a cost barrier by the majority of the projects.

TABLE 160. Cost as barrier

Q7. If you had to purchase the standards, data and/or tools, to what extent was their cost a barrier to using them?			
Please answer for each of the following aspects	Not at all	One of the factors	The main factor
7.1 The technical standards used	1	2	2
7.2 The databases used	1	4	0
7.3 Calculation and modelling tools	3	2	0

Note. Projects reported on this indicator: 7/18 - No response from 13/18.

Competences

The participants were asked to describe the previous experience of the test team with a similar indicator or life cycle tools. Their answers are summarised in Table 161 below.

TABLE 161. Previous experience with similar indicators or tools

Q8.	No previous experience	Limited previous experience	Some previous experience	Extensive previous experience
How would you describe the previous experience of th e test team with similar indicators or life cycle tools?	0	3	2	1

Note. Projects reported on this indicator: 7/18 - No response from 12/18.

According to the table above, half of the projects had limited previous experience with the indicator and life cycle tools while the other half had some and extensive experience.

Taking their previous experience into account, the respondents were asked to respond to the question about whether the use of the indicator required additional training and support. Their responses are summarised in the following Table 162.

TABLE 162. Need for additional training

Q9.1	Not at all	Limited extent	Moderat e extent	Great extent	Very great extent
Based on the previous experience of the test team, to what extent did using this indicator or life cycle tool require additional training and support?	0	1	2	2	0

Note. Projects reported on this indicator: 7/18 - No response from 13/18.

Most of the participants answering reported that the work needed additional training and support in a moderate or great extent.

Furthermore, the respondents were asked to elaborate on the type of training, which is required in order to use the indicator or life cycle tool as intended. Their responses are summarised in Table 163 below.

TABLE 163. Areas of additional training

Q9.2	Knowledge of standards or methods	Calculation or modelling tool software use	Access to and handling of data sets	Other (please specify)
If additional training and support was required, please identify the main areas where it was necessary	2	2	3	0

Note. Projects reported on this indicator: 7/18 - No response from 13/18.

According to the table above the suggestions were evenly spread out between standards, calculation tool and data. The respondents did not give any details of the type of training and/or support that was needed.

Table 164 gives an overview of the estimated costs in man days fulfilling the requirement for this particular indicator or tool. More than two-thirds of the respondents have not replied. The four participants replying have indicated a very wide range within the time spent on the indicator, from 0.2 day to four days,

TABLE 164. Estimated time consumption in man days

Q10.1 If possible please provide an estimate of the cost and/or time that were required to use this indicator or tool.	No response	0.2	1.5	4
	14	1	1	2

Table 165 gives an overview of the estimated costs in Euros for fulfilling the requirements for the particular indicator or tool. More than two-thirds of the respondents have not answered the question. The three answers received inciate a very wide range in the estimated costs (from EUR40 to EUR4,000).

TABLE 165. Estimated cost in Euros

Q10.2 If possible please provide an estimate of the cost and/or time that were required to use this indicator or tool.	No response	40	4000
	15	1	2

Suggestions for improvement

The participants were asked to make suggestions for improvements to the indicator that would make it easier to use. The following suggestions were received:

- It is difficult to understand what to do if there are no design aspects for the scope / building part - do you leave it empty? What is minimum necessary? For Level 2 the design tool shall be specified. But the definition of "design tool" is a little unsure. What is the meaning with "design tool"? In this case DGNB is the tool (as stated as a possibility in the comment in the tool, but is Revit a design tool for tis M.O?)
- Fairly easy to fill in the assessment tool. Very useful to have the drop-down menus.
- "Level 3 sets higher requirements than DGNB.
- It is a great advantage that Level 1 and 2 can be referred directly to a DGNB criterion"
- "Given the difficulties in reporting – based on the structure of elements and building parts - we are not sure if the current format is the best way of reporting on this important indicator. Further alignment with existing standards and guides could be of help, for example ISO 20887 Design for disassembly and adaptability of buildings and civil

engineering works – principles and guidance, or the tools developed in the European BAMB project.

- The drop-down menus and descriptions of choices is not very clear.
- Reporting for existing buildings should include the option “not possible”, as many parts of (existing) buildings were not designed for disassembly, reuse or recycling.
- If Level(s) is to be used for renovation cases, it should be possible to divide the building elements in the renovated part and existing part not affected by renovation.

The value of using Level 2 and Level 3

For this indicator, two projects reported on Level 2 and no project on Level 3.

TABLE 166. The value of using Level 2

	Not at all	Limited extent	Moderate extent	Great extent	Very great extent	Not sure
Q12.1 To what extent did Level 2 prove to be useful in making comparisons between buildings?	0	1	0	0	2	1

Note. Projects reported on this indicator: 7/18 - No response from 13/18.

If the value of using Level 2 was moderate or higher, the participants were asked to reflect on how its use influenced the results. Four projects replied on this question, while only two projects reported on the indicator. Out of those four replies, two projects reported that Level 2 proved to be useful at a very great extent, while one project reported in a limited extent. The following comments were received:

- A numerical output is easy to compare and understand for projects using the same tool.

No answers were received for Level 3 as no project worked with the indicator on Level 3.

Summary

The life cycle tool was tested by seven projects. The feedback on to what extent the life cycle tool was easy and logical to use was spread over the scale between “limited extent” to “great extent” and therefore difficult to draw any conclusions from the seven projects. It differed also between projects in what extent the projects encounter problems while working with the life cycle tool, half of the projects had no or limited problems while the other half had problems in moderate or great extent. The life cycle tool is related to a DGNB (TEC 1.6, PRO 1.3 and LCA) and projects also reported DGNB and LCA as relevant tools and access to data from previous assessments. The project teams had limited to some previous experience with working with similar requirements, and they reported that they needed additional training in moderate to a great extent.

6.3.4 Life cycle tool 2.4: Cradle to cradle Life Cycle Assessment (LCA)

When life cycle assessment (LCA) is carried out, several environmental impact categories are calculated. One of them is GWP, which in Level(s) is included as a separate Micro objective and indicator 1.2. The life cycle tool 2.4 includes an LCA where other environmental impact categories are calculated. The setting of the system boundaries in Level(s) shall follow the 'modularity principle' according to the EN 15978 standard for environmental assessment of buildings life cycle. Level(s) offers some simplified options by modelling some selected life cycle stages.

TABLE 167. Distribution on Level(s) reporting requirements

	Level 1	Level 2	Level 3
2.4 Life cycle tool: Cradle to cradle Life Cycle Assessment (LCA)	2	3	

Applicability and ease of use

This section of the survey focuses on Cradle to cradle Life Cycle Assessment (LCA). Two projects reported on Level 1 and three on Level 2. It has, therefore, to be kept in mind when looking at the results of the survey that only five out of 18 projects reported on this indicator.

Based on their experience with the indicator, the respondents were asked to evaluate whether the indicator was logical and easy to use. Specifically, the participants responded to the following question:

"To what extent was the indicator or life cycle tool easy and logical to use?"

The question above consisted of seven sub-questions, which the participants were asked to respond to. Their responses are summarised in the following table.

TABLE 168. Ease of use – indicator for Cradle to cradle Life Cycle Assessment (LCA)

Q1. To what extent was the indicator or life cy cle tool easy and logical to use?	Not at all	Limited extent	Moderate extent	Great extent	Very great extent	Not relevant to this test
1.1 The guidance for making a common performance assessment provided in the JRC Level(s) documentation	0	**3**	**2**	1	1	1
1.2 The calculation method(s) and standards that are specified should be used	0	0	**3**	**3**	0	1
1.3 The unit of measurement that is specified should be used	0	1	0	**6**	0	1
1.4 The reporting format that is provided in the documentation	0	1	**2**	**3**	1	1
1.5 The suggested calculation tools and reference data sources	0	0	**5**	1	1	1
1.6 If used, the Level 2 rules for comparative reporting	0	0	1	0	0	3
1.7 If used, the Level 3 aspects and guidance notes	0	0	0	0	0	4

Note. Projects reported on this indicator: 5/18 - No response from 9/18.

Table 168 illustrates that the projects reported that they were satisfied with the calculation methods, units are chosen, reporting format and the calculation tools (mainly by moderate to great extent), while they were a bit less satisfied with the guidance for making a common performance assessment (mainly by limited to a moderate extent).

The participants were asked to reflect on to what extent the indicator helped them to make a comparison of different building designs. Their responses are shown in Table 169 below.

TABLE 169. Supporting comparison of alternative design options

	Not at all	Limited extent	Moderate extent	Great extent	Very great extent	Not sure
Q2. If comparisons were made of different buildin g design options, to what extent did the indicator or life cycle tool help to do this?	1	0	0	0	0	4

Note. Projects reported on this indicator: 5/18 - No response from 13/18.

Subsequently, the participants were asked to reflect, to what extent whether they encountered any issues in obtaining the results for the indicator or life cycle tool. Their responses are summarised in Table 170.

TABLE 170. Extent of problems obtaining results

	Not at all	Limited extent	Moderat e extent	Great extent	Very great extent
Q3. To what extent did you encounter any problems in obtai ning a result for the indicator or life cycle tool?	0	1	6	0	0

Note. Projects reported on this indicator: 5/18 - No response from 13/18.

The results summarized in Table 170 above shows that most projects working with this indicator encountered problems in moderate extent. The type of problems mentioned was:

- "Some data is not given, in the Danish LCA-version (LCA byg).
- A4-5 & D is not achieved in present calculations."
- EPDs in Denmark are limited.
- Construction process and Benefits and loads beyond the boundary (D) is not a part of our calculation.

Accessibility to data, tools and standards

The respondents were asked to specify whether they had used other tools, datasets or references when making the assessments. The responses are summarized as in the table below.

TABLE 171. Use of other references, datasets or tools

	Yes	No
Q4. When making the assessment, were there any other specific references, datasets or tools you had used on other building assessments that proved useful?	4	2

Note. Projects reported on this indicator: 5/18 - No response from 12/18.

In supplementary comments, the respondents referred to the following tools and methods that were useful:

- LCA-worksheet which is a tool for DGNB, LCA-byg (DK SBi)

The table below summarises their access to the required results from other previous assessments of the building.

TABLE 172. Access to previous assessments

	Not at all	Limited extent	Moderate extent	Great extent	Very great extent
Q5. To what extent did you already have access to the required results from other assessments of the building?	0	1	0	3	3

Note. Projects reported on this indicator: 5/18 - No response from 11/18.

The participants identified the following sources of results, which were either available already or diverged from Level(s).

- LCAbyg
- An LCA was conducted as a part of the DGNB certification
- BoM and previous preliminary LCA during the buidling's design stage
- Construction process and Benefits and loads beyond the boundary (D) is not a part of our calculation.
- DGBN precertification has been carried out, therefore an LCA has been carried out with the tool used for LCA.

The participants were asked to respond to how available standards, tools or data were. The following Table 173 summarises the responses received.

TABLE 173. Availability of standards, data and/or tools

Q6.If you had to obtain the standards, data and/or tools in order to make the Level(s) assessment, how readily available were they?						
Please answer for each of the following aspects	Not possible to obtain	Difficult to obtain	Some effort to obtain	Easy to obtain	Already had them	*Not relevant to this test building*
6.1 The technical standards used	0	0	1	2	3	1
6.2 The databases used	0	2	1	0	3	1
6.3 Calculation and modelling tools	0	1	0	0	5	1

Note. Projects reported on this indicator: 8518 - No response from 11/18.

According to Table 173 above, the project participants answers differ somewhat. Most of the projects already had the necessary calculation and modelling tools, and about half of the project had already data and standards.

The projects were asked if they had to purchase the standards, data and/or tools, to what extent was their cost a barrier to using them. The results are shown in Table 174 below.

TABEL 174. Cost as barrier

Q7. If you had to purchase the standards, data and/or tools, to what extent was their cost a barrier to using them?			
Please answer for each of the following aspects	Not at all	One of the factors	The main factor
7.1 The technical standards used	5	1	1
7.2 The databases used	2	2	3
7.3 Calculation and modelling tools	2	4	1

Note. Projects reported on this indicator: 5/18 - No response from 11/18.

Competences

The participants were asked to describe the previous experience of the test team with a similar indicator or life cycle tools. Their answers are summarised in Table 175 below.

TABLE 175. Previous experience with similar indicators or tools

Q8.	No previous experience	Limited previous experience	Some previous experience	Extensive previous experience
How would you describe the previous experience of th e test team with similar indicators or life cycle tools?	0	1	3	3

Note. Projects reported on this indicator: 5/18 - No response from 11/18.

According to the table above, six out of seven projects had some or extensive previous experience with the indicator and life cycle tools.

Taking their previous experience into account, the respondents were asked to respond to the question about whether the use of the indicator required additional training and support. Their responses are summarised in the following Table 176.

TABLE 176. Need for additional training

Q9.1	Not at all	Limited extent	Moderat e extent	Great extent	Very great extent
Based on the previous experience of the test team, to what extent did using this indicator or life cycle tool require additional training and support?	3	1	3	0	0

Note. Projects reported on this indicator: 5/18 - No response from 11/18.

Half of the participant answered that the work with the indicator did not require additional training and support, while the other half needed that in limited to a moderate extent.

Furthermore, the respondents were asked to elaborate on the type of training, which is required in order to use the indicator or life cycle tool as intended. Their responses are summarised in Table 177 below.

TABLE 177. Areas of additional training

Q9.2	Knowledge of standards or methods	Calculation or modelling tool software use	Access to and handling of data sets	Other (please specify)
If additional training and support was required, please identify the main areas where it was necessary	1	3	2	0

Note. Projects reported on this indicator: 5/18 - No response from 12/18.

According to the table above the suggestions were spread out between standards, calculation tool and data, but showing that half of the projects identified calculation tools. The respondents further identified the type of training and/or support that was needed, but no answers were given.

Table 178 gives an overview of the estimated costs in man days fulfilling the requirement for this particular indicator or tool. More than two-thirds of the respondents have not replied. The four participants replying have indicated a very wide range within the time spent on the indicator. It varies from half a day to 5-10 days.

TABLE 178. Estimated time consumption in man days

Q10.1 If possible please provide an estimate of the cost and/or time that were required to use this indicator or tool.	No response	0-5	4	7	5-10
	14	1	1	1	1

Table 179 gives an overview of the estimated costs in Euros for fulfilling the requirements for the particular indicator or tool. Only two responses were received. The show a very wide range of the costs, from EUR800 to EUR5,000.

TABLE 179. Estimated cost in Euros

Q10.2 If possible please provide an estimate of the cost and/or time that were required to use this indicator or tool.	No response	800-1600	5000
	16	1	1

Suggestions for improvement

The participants were asked to make suggestions for improvements of the indicator that would make it easier to use. The following suggestions were received:

- This indicator is not named 2.4 in the tool. This is very confusing. In the report it is named 7.0!?
- "As a first comment, it has to be mentioned that the “cradle to cradle” definition is not according to the standards EN 15804 and EN 15978, mentioned in the guidance. The concept of cradle to cradle is focusing on circular economy initiatives and even though its use here aims to emphasize the focus towards a more sustainable circular approach in construction, it can also cause confusions and lead to misleading conclusions since it is basically opposing the approach for LCA as described in the standard and as it is known from LCA practitioners.
- Additionally, the simplified option includes only some life cycle stages, which is not even the case for the new EN 15804 standards, which encourage the whole cradle to grave approach. It is understood that the aim here is a simplified approach, but instead of neglecting very important operational and end of life stages, which are often crucial to the final impact assessment, the possibility of applying scenarios and the results of the other mandatory indicators in the guidance could be set here.
- In general, the perception from the guidance in the LCA indicator is that Level 1 assessment is intended to be a very simplistic assessment, focusing on only some of the areas. However, Level 1 assessment means building assessment without benchmarking or improvement options. This is the present practice in most of the assessments done today. When a building is assessed for example in terms of LCA it does not mean that by not doing a benchmark, the assessment done was simplified in terms of life cycle stages and assumptions. Detailed Level 1 assessments can be done and guidance for those is not provided. The user has to read and apply the guidance from levels 2 and 3 but without implementing the benchmarking and improvement options, in order to deliver complete results. I believe a better definition of the levels is needed and the same amount of information and guidance shall be provided for all of them, in terms of the level of detail, with the possibility of the user to select, in level 1a simplified or detailed approach.
- Furthermore, when the reporting for the 7, the reporting for indicator 1.2 is redundant and the option to neglect it should be applied. Otherwise, it can be the case that the same reporting, with regards to underlying assumptions for modelling and performing the

assessment is applied in both indicators, which increases the time and reporting requirements without adding any value to the results.

- Finally, with reference to the guidance for assessing the Abiotic Depletion Potential (ADP) indicator, it is not clear whether Levels encourages taking into account other indicators, such as the depletion of non-mineral and biomass sources or whether it provides a method to assess the two existing ones (ADP elements and fuels). If the former is true, the approach is contradicting the guidance from the EN and ISO standards, while a comprehensive approach to calculate the additional indicators does not exist. If the latter is true, the approach proposed is very much time consuming and unrealistic to be done, alongside the other reporting requirements from Levels.
- For LCA, I also see a problem in that they would not be performed for all renovation cases. There are no requirements for LCA for renovations, and unless a DGNB certification is carried out, I believe that the few renovation cases that perform LCA - especially for minor cases. Thus, Level(s) is also a major challenge that requires a relatively large effort for renovation projects. It could be interesting if there could be some focus points and general topics that could be discussed and analyzed at different levels. (focus on specific materials, eco-labels, reduction of materials, recycling, etc.) I also do not think that the 3 level(s) make such great sense in relation to a renovation case, especially not at all stages. There is also some more explanation as to what phases to include and how. DGNB does not look at the existing building (which is not being renovated), where it is uncertain how much Level(s) has this included.
- If this is referring to the tab "LCA Design" in the EU reporting tool, this should just be incorporated in the indicator 1.2

The value of using Level 2 and Level 3

For this indicator, three projects reported on Level 2 and no project on Level 3. If the value of using Level 2 was moderate or higher, the participants were asked to reflect on how its use influenced the results.

TABLE 180. The value of using Level 2

	Not at all	Limited extent	Moderate extent	Great extent	Very great extent	Not sure
Q12.1 To what extent did Level 2 prove to be useful in making comparisons between buildings?	1	1	0	0	0	1

Note. Projects reported on this indicator: 5/18 - No response from 15/18.

Summary

The life cycle tool was tested by five projects. The feedback on to what extent the life cycle tool was easy and logical to use was spread over the scale between “limited extent” to “very great extent” and therefore difficult to draw any conclusions from the five projects. The projects encountered problems in moderate extent while working with the life cycle tool. Some projects had worked with DGNB and had therefore carried out an LCA. But there are some inconsistencies between the system boundaries required in Level(s) and the ones that have been chosen for the LCA tools developed in Denmark (A4-A5 and module D have are not yet included in the Danish tools). When excluding those inconsistencies, the project could access data from existing tools and previous assessments. No project team did not have any previous experience with LCA and three projects had extensive previous experience.

6.3.5 Life cycle tool 5.1: scenario 1 – Protection of occupier health and thermal comfort

Life cycle tool 5.1 Scenario 1 – Protection of occupier health and thermal comfort focus on the protection of health and comfort under projected future climate conditions, while only initial guidance is provided to sustain and minimise risks to property values due to extreme weather events and flooding. The same calculation methodology as for indicator 4.2 shall be used for assessing future scenarios for the thermal comfort of the interior spaces of buildings by simulating the building's projected time out of thermal comfort range for the years 2030 and 2050 (JRC – Joint Research Centre, European Commission (2017a: 55-56).

Table 181 shows the distribution of projects testing this indicator on each of the three levels. Approximately one-third of the projects have tested this indicator, mostly on Level 1 and a few projects on Level 3.

TABLE 181. Distribution on Level(s) reporting requirements

	Level 1	Level 2	Level 3
5.1 Life cycle tool: scenario 1 – Protection of occupier health and thermal comfort	4	0	2

Applicability and ease of use

This section of the survey focuses on the protection of occupier health and thermal comfort. Based on their experience with the indicator, the respondents were asked to elucidate whether the indicator was logical and easy to use. Specifically, the participants responded to the following question:

"To what extent was the indicator or life cycle tool easy and logical to use?"

The question above consisted of seven sub-questions. The responses are summarised in Table 182. The number of responses is very low and quite evenly distributed. Hence, it is difficult to draw any firm conclusions as to the ease of use of the indicator.

TABLE 182. Ease of use – indicator for u Protection of occupier health and thermal comfort

Q1. To what extent was the indicator or life cyc le tool easy and logical to use?	Not at all	Limited extent	Moderate extent	Great extent	Very great extent	Not relevant to this test
1.1 The guidance for making a common performance assessment provided in the JRC Level(s) documentation	0	1	1	1	1	1
1.2 The calculation method(s) and standards that are specified should be used	0	1	1	2	0	1
1.3 The unit of measurement that is specified should be used	0	2	0	2	0	1
1.4 The reporting format that is provided in the documentation	0	0	3	1	0	1
1.5 The suggested calculation tools and reference data sources	0	0	1	3	0	1
1.6 If used, the Level 2 rules for comparative reporting	0	0	2	0	0	3
1.7 If used, the Level 3 aspects and guidance notes	0	0	0	0	0	5

Note: Responses from 5 out of 18 projects.

Table 183 below illustrates the potential of the indicator in order to make comparisons between different building designs. The number of respondents is very low, and the results are inconclusive. Apparently the few respondents were uncertain as to the use of this indicator in comparing alternative design options.

TABLE 183. Supporting comparison of alternative design options

Q2.	Not at all	Limited extent	Moderate extent	Great extent	Very great extent	Not sure
If comparisons were made of different building design options, to what extent did the indicator or life cycle tool help to do this?	0	0	0	0	0	4

Note: Responses from 4 out of 18 projects.

Furthermore, the participant was asked to reflect on whether or not they encountered any problems when working with the indicator. As seen in Table 184 below only four respondents have addressed this section. The respondents have encountered problems with a limited and moderate extent when working with the tool.

TABLE 184. Extent of problems obtaining results

Q3.	Not at all	Limited extent	Moderate extent	Great extent	Very great extent
To what extent did you encounter any problems in obtaining a result for the indicator or life cycle tool?	0	2	2	0	0

Note: Responses from 4 out of 18 projects.

Accessibility to data, tools and standards

The participants were asked whether they had used additional tools, datasets or references when doing the assessment. Table 185 below summarises the responses.

TABLE 185. Use of other references, datasets or tools

Q4.	Yes	No
When making the assessment, were there any other specific references, datasets or tools you had used on other building assessments that proved useful?	4	0

Note: Responses from 4 out of 18 projects.

Moreover, the respondents pointed at the following other tools, datasets or references as additional resources, namely DGNB certification and the simulation tools BSim (for the calculation of the performance aspect), IDA Indoor Climate and Energy and IES-VE.

Table 186 below focuses on whether the participants already had access to the required results from other assessments. Again, the number of respondents is very low, but there seems to be some access to previous assessments from using BSim and a digital model of the building.

TABLE 186. Access to previous assessments

Q5.	Not at all	Limited extent	Moderate extent	Great extent	Very great extent
To what extent did you already have access to the required results from other assessments of the building?	0	2	1	1	0

Note: 4 out of 18 projects answered.

Table 187 below shows the availability of the standards, tools and references. The few responses indicate that standards, data and tools have been readily available.

TABLE 187. Availability of standards, data and/or tools

Q6.If you had to obtain the standards, data and/or tools in order to make the Level(s) assessment, how readily available were they?						
Please answer for each of the following aspects	Not possible to obtain	Difficult to obtain	Some effort to obtain	Easy to obtain	Already had them	*Not relevant to this test building*
6.1 The technical standards used	0	0	0	3	1	0
6.2 The databases used	0	0	3	1	0	0
6.3 Calculation and modelling tools	0	0	0	1	3	0

Note: Responses from 4 out of 18 projects.

The barrier effect of the cost of the required sources is shown in Table 188 below. The responses indicate that the cost did not have a significant effect on using the standards, tools and references.

TABLE 188. Cost as barrier

Q7.If you had to purchase the standards, data and/or tools, to what extent was their cost a barrier to using them?			
Please answer for each of the following aspects	Not at all	One of the factors	The main factor
7.1 The technical standards used	2	2	0
7.2 The databases used	0	2	2
7.3 Calculation and modelling tools	2	2	0

Note: 4 out of 18 projects answered.

Competences

The previous experience of the participants is illustrated in Table 189 below. Based on the few responses received, all the participants had some previous experience with similar life cycle tools.

TABLE 189. Previous experience with similar indicators or tools

Q8.	No previous experience	Limited previous experience	Some previous experience	Extensive previous experience
How would you describe the previous experience of the test team with similar indicators or life cycle tools?	0	0	3	0

Note: Responses from 3 out of 18 projects.

Based on their previous responses, the participants were asked to respond to whether additional training and support was required in order to fulfil the task. The responses are shown in Table 190 below.

TABLE 190. Need for additional training

Q9.1	Not at all	Limited extent	Moderate extent	Great extent	Very great extent
Based on the previous experience of the test team, to what extent did using this indicator or life cycle tool require additional training and support?	2	1	0	1	0

Note: Responses from 4 out of 18 projects.

Subsequently, the respondents were asked to specify the main areas where additional training is required. The very few responses are shown in Table 191 below.

TABLE 191. Areas of additional training

Q9.2	Knowledge of standards or methods	Calculation or modelling tool software use	Access to and handling of data sets	Other (please specify)
If additional training and support was required, please identify the main areas where it was necessary	0	0	1	1

Note: Responses from 2 out of 18 projects.

Table 192 gives an overview of the estimated costs in man days for fulfilling the requirement for this particular indicator or tool. No respondents have answered the question.

TABLE 192. Estimated time consumption in man days

Q10.1	No response
If possible please provide an estimate of the cost and/or time that were required to use this indicator or tool.	18

Note: Responses from 0 out of 18 projects.

Table 193 gives an overview of the estimated costs in Euros for fulfilling the requirement for this particular indicator or tool. No respondents have answered the question.

TABLE 193. Estimated cost in Euros

Q10.2	No response
If possible please provide an estimate of the cost and/or time that were required to use this indicator or tool.	18

Note: Responses from 0 out of 18 projects.

Suggestions for improvement

The respondents were asked to make suggestions for improvements that would make it easier to use the indicator or the life cycle tool. Their suggestions are listed below:

- It is difficult to understand, what is meant with A1B? The scenarios are explained in another report. In general there are many different reports to examine, which makes Level(s) time consuming and difficult to use. I am missing a part for documenting the current scenario as a comparison to the starting point.

- Propose default scenarios of temperature increase and other possible changes in weather conditions.
- Assess the impact that the climate change can have in the building materials themselves and their durability apart from the thermal comfort of the building. Have some quantitative assessment of the level of deterioration of the materials as a result of more extreme weather conditions. This will lead to selection of more durable and resilient materials with a longer lifetime.
- Longer life cycle perspective as in LCA, e.g. 50-100 years?
- If an indoor climate simulation had not been performed for this case, information would probably not be available for this macro objective. It would be fine if some more general discussion topics could be raised which did not necessarily require a simulation. It will probably be major renovations that will have indoor climate simulation done, and thus smaller projects will not look at this critique. However, I think it is an interesting topic that is not included in DGNB either.

The value of using Level 2 and Level 3

For this indicator, 0 projects reported on Level 2 and 2 projects on Level 3. Still, 4 projects answered the question, although the respondents are effectively only 2 project teams as these 2 teams have conducted 2 assessments each. The respondents consider the value of using Level 2 to be either limited or uncertain (Table 194).

TABLE 194. The value of using Level 2

	Not at all	Limited extent	Moderate extent	Great extent	Very great extent	Not sure
Q12.1 To what extent did Level 2 prove to be useful in making comparisons between buildings?		2				2

Note. Responses: 4/18 – 0 projects reported on Level 2

With regard to the usefulness of applying Level 2 the respondents added the following comments:

- Simulations as in DGNB criterion SOC1.1. Including scenario modelling for 2030 and 2050 and fixed parameters.
- It is not clear in the guidance how to document the data quality and how to upload the relevant supporting documentation for it.

The respondents consider the value of using Level 2 to be either limited or uncertain (Table 195).

TABLE 195. The value of using Level 3

	Not at all	Limited extent	Moderate extent	Great extent	Very great extent	Not sure
Q13.2 To what extent did Level 3 prove useful in obt aining more precise and reliable results?						4

Note. Responses 4/18 – 2 projects reported on Level 3

With regard to the usefulness of applying Level 3 the respondents added the following comments:

- Performance optimisation. Aspect 3: notes and data sources is available for DGNB projects. Aspect 1 and 2 seems advanced and out of boundary.

Summary

The number of responses in this section is very low compared to the previous sections. Thus, it is difficult to draw any solid conclusions concerning the applicability of the life cycle tool, accessibility of data etc. and competences. Instead, the most important observation is that this life cycle tool is seldom applied in Danish construction, not even in DGNB certified projects.

6.3.6 Indicator 6.1: Life Cycle Cost (LCC)

Indicator 6.1 Life Cycle Cost (LCC) focuses on the life cycle costs of a building covering construction, operation, maintenance, refurbishment and disposal. The indicator measures all building element costs incurred at each life cycle stage of a project for the reference study period, and assumptions about future cost relating to maintenance, repair and replacements shall also be accounted for. If not all life cycle stages are considered, the minimum scope of reporting is required for the following stages (JRC – Joint Research Centre, European Commission (2017a: 58-59):

- Use stage energy and water costs (life cycle stages B6 and B7).
- Construction and long-term maintenance, repair and replacement costs (life cycle stages A1-3/B2–4).

Table 196 shows the distribution of projects testing this indicator on each of the three levels. Two-thirds of the projects have tested this indicator on either of the three levels. One-third has tested this indicator on Level 3.

TABLE 196. Distribution on Level(s) reporting requirements

	Level 1	Level 2	Level 3	N/A
6.1 Life Cycle Cost (LCC)	4	2	6	6

Applicability and ease of use

The focus of this section is to elucidate the potential of indicator or life cycle tool in relation to Life Cycle Cost (LCC) analysis. The participants were asked to reflect on the same questions as previous sections:

> *To what extent was the indicator or life cycle tool easy and logical to use?"*

The question above consisted of seven sub-questions. The responses are summarised in Table 197. The number of responses covers half of the test projects.

TABLE 197. Ease of use – indicator for Life Cycle Cost (LCC)

Q1. To what extent was the indicator or life cycl e tool easy and logical to use?	Not at all	Limited extent	Moderate extent	Great extent	Very great extent	Not relevant to this test
1.1 The guidance for making a common performance assessment provided in the JRC Level(s) documentation	0	5	4	0	0	0
1.2 The calculation method(s) and standards that are specified should be used	0	4	3	1	1	0
1.3 The unit of measurement that is specified should be used	0	4	2	3	0	0
1.4 The reporting format that is provided in the documentation	0	4	5	0	0	0
1.5 The suggested calculation tools and reference data sources	0	2	5	1	1	0
1.6 If used, the Level 2 rules for comparative reporting	1	1	3	3	0	1
1.7 If used, the Level 3 aspects and guidance notes	0	2	1	0	0	5

Note. Responses from 9 (or 8) out of 18 projects.

The main part of the participants has responded that the indicator or the tool is only to a limited or moderate extent logical and easy to use when working with Life Cycle Cost (LCC) analysis.

The participants were asked whether the indicator is helpful when making comparisons between different building designs. The responses are shown in Table 198 below.

TABLE 198. Supporting comparison of alternative design options

Q2.	Not at all	Limited extent	Moderate extent	Great extent	Very great extent	Not sure
If comparisons were made of different building des ign options, to what extent did the indicator or life cycle tool help to do this?	1	1	0	0	0	6

Note: Responses from 8 out of 18 projects.

The problems encountered by the participants when using the indicator or the tool are summarised in Table 199 below. The respondents experienced difficulties in a limited or moderate extent.

TABLE 199. Extent of problems obtaining results

Q3.	Not at all	Limited extent	Moderat e extent	Great extent	Very great extent
To what extent did you encounter any problems in obtaining a result for the indicator or life cycle tool?	2	2	4	1	0

Note: Responses from 9 out of 18 projects.

Subsequently the respondents were asked to specify the type of problems they have encountered when using the indicator or the tool. Their responses include:

- There are different discount rates and reference study periods in the technical report and in the tool.

- Some of the needed results are not provided by LCCbyg, and it is not known how to achieve the results.
- The discount rate is a nominal rate in Danish context, and the reported values are based on a nominal rate (see reporting tool).
- The life span is not consistent between manual and calculation requirements (50 or 60 years?).
- In a Danish context the EoL disposal costs is typically not part of an LCC calculation.
- Difficult to evaluate the indicator, if you have not previous experience. It is also not clear and rather confusing which are the default discount and inflation rates to be used. Additionally, having a building constructed earlier than 2015 added some complexity in having 2015 as the reference year. It is understood that the purpose is benchmarking with other buildings, built at different times, yet the purpose of internally evaluating the LCC of your building could be fulfilled by having the reference year set to the year that the building is built.
- Excel is not flexible enough to add other cost categories and additional columns than the ones defined.
- No guidance is given for the case that we have different currency than Euro.
- For this renovation case, an LCC analysis was made in connection with DGNB's pre-certification. Thus, it was possible to acquire most inputs for this macro objective. However, demands are not made in the same way for renovation cases to make an LCC analysis, and thus it is considered a great task of performing and it would be problematic to obtain data for the criterion.

Accessibility to data, tools and standards

Table 200 below summarises the responses focusing on whether the participants have used additional sources from other projects.

TABLE 200. Use of other references, datasets or tools

Q4.	Yes	No
When making the assessment, were there any other specific references, datasets or tools you had used on other building assessments that proved useful?	9	0

Note: Responses from 9 out of 18 projects.

Furthermore, the participants were asked to specify the additional useful tools that they have used in previous projects. The following tools and references were identified:

- LCC tool used in DGNB – DK.
- DGNB standard assumptions and prerequisites.
- LCCbyg (Danish LCC tool).
- Excel.
- Other methods than the Level(s) part 3: DGNB-method.
- Other references than the Level(s) part 3: Danish SBi-references.

Table 201 below illustrates whether the participants had already access to other assessments of the building. Most respondents had access to results from other assessments from using LCCbyg and/or doing a DGNB certification of the project.

TABLE 201. Access to previous assessments

Q5	Not at all	Limited extent	Moderate extent	Great extent	Very great extent
To what extent did you already have access to the req uired results from other assessments of the building?	1	1	1	5	1

Note: Responses from 9 out 18 projects.

The availability of the standards, tools and references is shown in Table 202 below. As seen in the table, all the necessary sources have been available and easy to access.

TABLE 202. Availability of standards, data and/or tools

Q6.If you had to obtain the standards, data and/or tools in order to make the Level(s) assessment, how readily available were they?						
Please answer for each of the following aspects	Not possible to obtain	Difficult to obtain	Some effort to obtain	Easy to obtain	Already had them	*Not relevant to this test building*
6.1 The technical standards used	0	0	1	0	8	0
6.2 The databases used	0	0	2	0	7	0
6.3 Calculation and modelling tools	0	0	2	0	7	0

Note: Responses from 9 out of 18 projects.

The participants were asked to respond to whether the cost of the sources has been a barrier to using them. The responses are shown in Table 203 below. As seen below, the cost was not a barrier for the majority of respondents, although some express that cost has to some extent been a barrier.

TABLE 203. Cost as barrier

Q7. If you had to purchase the standards, data and/or tools, to what extent was their cost a barrier to using them?			
Please answer for each of the following aspects	Not at all	One of the factors	The main factor
7.1 The technical standards used	5	3	0
7.2 The databases used	4	4	0
7.3 Calculation and modelling tools	5	1	2

Note: Responses from 8 (or 9) out of 18 projects.

Competences

The previous experience of the participants is shown in Table 204 below. The majority of respondents have some or extensive previous experience with similar indicators or life cycle tools.

TABLE 204. Previous experience with similar indicators or tools

Q8.	No previous experience	Limited previous experience	Some previous experience	Extensive previous experience
How would you describe the previous experience Of the test team with similar indicators or life cycle tools?	0	2	4	3

Note: Responses from 9 out of 18 projects.

Based on their previous responses, the participants were asked to respond to whether additional training and support was required in order to fulfil the task. The responses are shown in Table 205 below. There seems to be very little need for additional training.

TABLE 205. Need for additional training

Q9.1	Not at all	Limited extent	Moderate extent	Great extent	Very great extent
Based on the previous experience of the test team, to what extent did using this indicator or life cycle tool require additional training and support?	5	3	1	0	0

Note: Responses from 9 out of 18 projects.

The respondents have identified some main areas where additional training and support is required. The following Table 206 shows their responses.

TABLE 206. Areas of additional training

Q9.2	Knowledge of standards or methods	Calculation or modelling tool software use	Access to and handling of data sets	Other (please specify)
If additional training and support was required, please identify the main areas where it was necessary	1	3	2	1

Note: Responses from 7 out of 18 projects.

The participants were asked to further identify the type of training that was required in order to fulfil the task. Their responses include:

- Software use.
- Getting familiar with the Level(s) Excel spreadsheet, since this macro objective was the one we started with.

Table 207 gives an overview of the estimated costs in man days for fulfilling the requirement for this particular indicator or tool. More than one-third of the respondents have not replied, about one-third have spent a day or less, and a smaller group has spent 2 or more days.

TABLE 207. Estimated time consumption in man days

Q10.1	No response	0.1	1	3	7	10
If possible please provide an estimate of the cost and/or time that were required to use this indicator or tool.	12	1	1	1	1	2

Note: Responses from 8 out of 18 projects.

Table 208 gives an overview of the estimated costs in Euros for fulfilling the requirement for this particular indicator or tool. Half of the respondents have not answered the question. The responses cover a very wide range all the way from EUR40 to EUR25,000 with an average around EUR1,000.

TABLE 208. Estimated cost in Euros

Q10.2	No response	800	5,000	10,000
If possible please provide an estimate of the cost and/or time that were required to use this indicator or tool.	14	1	1	2

Note: Responses from 4 out of 18 projects.

Suggestions for improvement

The respondents provided the following suggestions for improvements of the indicator or life cycle tool:

- Would prefer to use DGNB standard conditions as they’re already known and used in Denmark. This makes calculation easier/faster and makes them more comparable to each other.
- In part 6.1 “Accounting for a Level(s) assessment - version of the criteria used”, a date for the version is asked for. However, the used valuation set in this project uses a number as version.
- Evaluate how realistic the refurbishment and EoL inputs can be. Evaluate how large/small influence cleaning has. In Denmark it has been found, that the influence from cleaning is large.
- By making an LCC-calculation you can easily fill in Level 1 and Level 2. Beware: Do not change in the LCCbyg analysis; use the Danish standards and report that other values and phases have been used. In the performance assessment results table: Stage A, B and C are mentioned as "type of cost". B4 "Projected non-annual costs" is not a part of the Danish LCC calculation – will not be completed. A fixed rate/currency from national value (DKK) to EURO. Time: Most of the information to fill out level 1, 2 and 3 is already there, if a DGNB certification is made of the building. New project: Most of the time will be spent on getting information.
- Checklists are difficult to assess for a building in use. Differentiation between existing and new buildings would be useful. Not sure whether the 2015 baseline offers the correct indication for an assessment of the investment against the operational costs of the building. The excel template has to have greater flexibility in adding additional columns for other types of costs.
- For the present project, there have been two advantages compared to performing this macro objective in Level(s). One is the actual size of the renovation project, which means that a larger economic analysis is carried out and processed, which in turn means that more of the different inputs to macro objectives from Level(s) are processed. However, there is a need for a more general method for smaller cases or for the inputs that can be obtained in Danish cases. Equally, it must be made clearer which of the different phases are included in Level(s). It is uncertain whether content in the existing building is also looked at or only the renovated part. There is also a DGNB pre-certification, where through these many criteria have been filled out that are similar to those from Level(s), including an LCC calculation. However, there is nothing in the calculation itself or in data requested by Level(s) that directly indicates that it is for a renovation case.

The value of using Level 2 and Level 3

For this indicator, 2 projects reported on Level 2 and 6 projects on Level 3. Still, all 8 project teams have answered the questions regarding Level 2. The majority of respondents consider the value of using Level 2 to be moderate or less (Table 209). No additional comments were provided regarding Level 2.

TABLE 209. The value of using Level 2

	Not at all	Limited extent	Moderate extent	Great extent	Very great extent	Not sure
Q12.1 To what extent did Level 2 prove to be useful in making comparisons between buildings?	2	3	2			1

Note. Responses: 8/18 – 2 projects reported on Level 2

The majority of respondents consider the value of using Level 3 to be uncertain, limited or moderate, while 2 respondents consider Level 3 to be useful to a very great extent (Table 210).

TABLE 210. The value of using Level 3

	Not at all	Limited extent	Moderate extent	Great extent	Very great extent	Not sure
Q13.2 To what extent did Level 3 prove useful in obt aining more precise and reliable results?		2	1		2	2

Note. Responses 7/18 – 6 projects reported on Level 3

With regard to the usefulness of applying Level 3 the respondents added the following comments:

- Good that conditions for the calculation are evaluated, but same conditions has to be used to make reasonable comparisons.
- The evaulation and visualization of the type of data source is great for starting a dialog about improvement.
- The aspects are useful to remind the team to address these topics.
- "Design optimisation aspects addressed" were not done, but this is highly useful.

Summary

With regard to the applicability of the indicator of life cycle costing (LCC), the majority of respondents find that the indicator is only to a limited or moderate extent easy to use in its present form.

With regard to accessibility of data, tools and references, the majority of respondents have applied additional sources, especially the use of the DGNB certification and the Danish national tool LCCbyg. All the necessary sources have been available and easy to access.

With regard to competences, the majority of respondents have some or extensive previous experience with similar indicators or life cycle tools.

The respondents provide a number of suggestions for improvements of the indicator or life cycle tool of LCC. The most prominent suggestion is to apply the DGNB standard conditions and use LCCbyg as these are already well-known and used in Denmark.

6.3.7 Indicator 6.2: Value creation and risk factors

Indicator 6.2 Value creation and risk factors focus on those aspects of a more sustainable building performance that have the potential to create financial value or to expose owners and investors to risks and liabilities in the future. Further, the indicator provides information on the reliability of the underlying data and calculation methods on which a reported performance is based, to those involved in the appraisal of the value of a building (JRC – Joint Research Centre, European Commission (2017a: 62).

Table 211 shows the distribution of projects testing this indicator on each of the three levels. Only four projects have tested this indicator. All four projects have tested the indicator on Level 1.

TABLE 211. Distribution on Level(s) reporting requirements

	Level 1	Level 2	Level 3	N/A
6.2 Value creation and risk factors	4	0	0	14

Applicability and ease of use

This indicator focus on those aspects of a more sustainable building performance that have the potential to create financial value or to expose owners and investors to risks and liabilities in the future. The participants responded to the following question:

"To what extent was the indicator or life cycle tool easy and logical to use?"

The question above consisted of seven sub-questions. The responses are summarised in Table 212. The number of responses covers between one-third and half of the test projects. The responses indicate that the tool was mostly considered irrelevant to this test.

TABLE 212. Ease of use – indicator for Value creation and risk factors

Q1. To what extent was the indicator or life cy cle tool easy and logical to use?	Not at all	Limited extent	Moderate extent	Great extent	Very great extent	Not relevant to this test
1.1 The guidance for making a common performance assessment provided in the JRC Level(s) documentation	0	3	2	1	2	0
1.2 The calculation method(s) and standards that are specified should be used	0	0	1	2	0	5
1.3 The unit of measurement that is specified should be used	0	0	0	3	1	5
1.4 The reporting format that is provided in the documentation	0	1	1	3	1	2
1.5 The suggested calculation tools and reference data sources	0	0	0	2	0	6
1.6 If used, the Level 2 rules for comparative reporting	0	0	0	0	0	6
1.7 If used, the Level 3 aspects and guidance notes	0	0	0	0	0	6

Note: Responses from 6-8 out of 18 projects.

The potential of the indicator to make comparisons between different building designs is shown in Table 213 below. The responses indicate that the indicator has either not been supportive or it is uncertain whether it is supportive.

TABLE 213. Supporting comparison of alternative design options

Q2.	Not at all	Limited extent	Moderate extent	Great extent	Very great extent	Not sure
If comparisons were made of different building design options, to what extent did the indicator or life cycle tool help to do this?	3	0	0	1	0	3

Note: Responses from 7 out of 18 projects.

Table 214 below illustrates the extent of problems that the participants have encountered when obtaining a result for the indicator or the tool. As shown in the able above, the main part of the participant did not encounter any problems at all, whereas few have encountered problems to a limited extent.

TABLE 214. Extent of problems obtaining results

Q3.	Not at all	Limited extent	Moderate extent	Great extent	Very great extent
To what extent did you encounter any problems in obtaining a result for the indicator or life cycle tool?	5	3	0	0	0

Note: Responses from 8 out of 18 projects.

The participants were asked to specify the type of problems they encountered. Their responses are listed below:

- There are some incorrect references to some of the other macro objectives assessments. Some of the reliability ratings are linked to the wrong cells. This is, amongst others: 2.2S2, 2.2.S3 and 2.3.
- As such, there are no problems in obtaining a result from the table in macro objective 6.2 as it is relatively simple and summarises the other macro objectives. However, it is uncertain what it should be used for, also during renovation, as it is a quality assurance of input and not an assessment of the data itself and the inputs given to the Level(s) documentation. The table thus does not show any direct assessment or picture of the sustainability of the project.

Accessibility to data, tools and standards

Table 215 below illustrates whether the participants have used additional sources to make the assessments. As shown in Table 215 below, the participants had not used any additional sources when making the assessments.

TABLE 215. Use of other references, datasets or tools

Q4.	Yes	No
When making the assessment, were there any other specific references, datasets or tools you had used on other building assessments that proved useful?	0	8

Note: Responses from 8 out of 18 projects.

Table 216 below illustrates the accessibility of the required results from other assessments of the building. In general, the respondents had to great or very great extent access to the required results from other assessments of the building.

TABLE 216. Access to previous assessments

Q5.	Not at all	Limited extent	Moderate extent	Great extent	Very great extent
To what extent did you already have access to the required results from other assessments of the building?	1	1	0	2	4

Note: Responses from 8 out of 18 projects.

Table 217 below shows the results of how readily available standards, data and/or tools where for the respondents if the respondents needed to obtain these in order to carry out the assessment. All respondents – although only half has answered the question – declare that it was not relevant for their building.

TABLE 217. Availability of standards, data and/or tools

Q6.If you had to obtain the standards, data and/or tools in order to make the Level(s) assessment, how readily available were they?						
Please answer for each of the following aspects	Not possible to obtain	Difficult to obtain	Some effort to obtain	Easy to obtain	Already had them	*Not relevant to this test building*
6.1 The technical standards used	0	0	0	0	0	8
6.2 The databases used	0	0	0	0	0	8
6.3 Calculation and modelling tools	0	0	0	0	0	8

Table 218 below shows the results of whether the respondents considered the cost of purchasing the standards, data and/or tools a barrier to do the Level(s) assessment. Only a few respondents have answered the question, but most do not consider it to be a barrier at all.

TABLE 218. Cost as barrier

Q7. If you had to purchase the standards, data and/or tools, to what extent was their cost a barrier to using them?			
Please answer for each of the following aspects	Not at all	One of the factors	The main factor
7.1 The technical standards used	3	1	0
7.2 The databases used	3	1	0
7.3 Calculation and modelling tools	3	1	0

Note: Responses from 4 out of 18 projects.

Competences

The previous experience of the respondents with similar indicators or life cycle tools are summarised in Table 219 below. The majority of respondents have no or little previous experience with similar indicators or tools.

TABLE 219. Previous experience with similar indicators or tools

Q8.	No previous experience	Limited previous experience	Some previous experience	Extensive previous experience
How would you describe the previous experience of the test team with similar indicators or life cycle tools?	7	1	0	0

Note: Responses from 8 out of 18 projects.

Based on the previous question, the respondents were asked to reflect on whether they require additional training and support in order to fulfil the tasks. Table 220 below illustrates their responses stretching from no need at all and up to need to a great extent for additional training.

TABLE 220. Need for additional training

Q9.1	Not at all	Limited extent	Moderate extent	Great extent	Very great extent
Based on the previous experience of the test team, to what extent did using this indicator or life cycle tool require additional training and support?	3	0	3	2	0

Note: Responses from 8 out of 18 projects.

In addition, the respondents were asked to identify the main areas where additional training and support is required. The responses are summarised in Table 221 below. According to the responses listed in the table below, additional training is required within the following areas, although the number of responses is very low:

- Knowledge of standards or methods.
- Access to and handling of data sets.

TABLE 221. Areas of additional training

Q9.2	Knowledge of standards or methods	Calculation or modelling tool software use	Access to and handling of data sets	Other (please specify)
If additional training and support was required, please identify the main areas where it was Necessary	3	0	2	1

Note: Responses from 6 out of 18 projects.

Table 222 gives an overview of the estimated costs in man days for fulfilling the requirement for this particular indicator or tool. The vast majority of respondents have not replied to the question.

TABLE 222. Estimated time consumption in man days

Q10.1	No response	0,1	1
If possible please provide an estimate of the cost and/or time that were required to use this indicator or tool.	16	1	1

Table 223 gives an overview of the estimated costs in Euros for fulfilling the requirement for this particular indicator or tool. Only one of the respondents have answered the question.

TABLE 223. Estimated cost in Euros

Q10.2	No response	1,000
If possible please provide an estimate of the cost and/or time that were required to use this indicator or tool.	17	1

Suggestions for improvement

Below are listed suggestions made by the respondents in order to improve the indicator:

- Make it more clear in the other macro objectives that the data input is rated in this macro objective (number 6.2).
- It is difficult to understand if the rating is for all levels or only Level 1 and 2.
- In order to fill in the macro objective, data from all the other macro objectives is needed.
- Macro objective 6.2 as such is a fine summary of the included criteria in Level(s). It provides a kind of quality assurance and insight into the level of input and is easy to use as a comparison with other projects. Quality assurance and snapshot may also be lacking in other sustainability coherence. However, it gives no picture of the actual sustainability of the project. It also does not indicate anything about the 3 possible levels or the phase in which the renovation project is in.

The value of using Level 2 and Level 3

For this indicator, the value of using Level 2 and Level 3 is not relevant. Hence, no tables or comments are provided.

Summary

In general, it should be cautioned that the number of respondents is low. With regard to the applicability of the indicator of value creation and risk factors, the majority of respondents find that the indicator is easy to use.

With regard to accessibility of data, tools and references, none of the respondents has applied additional sources as the necessary source of data effectively is results from the other macro objectives.

With regard to competences, the majority of respondents have no or little previous experience with similar indicators or life cycle tools.

The respondents provide only a few suggestions for improvements to the indicator or life cycle tool.

7

LESSONS LEARNED FROM WORKSHOPS

7 LESSONS LEARNED FROM WORKSHOPS

7.1 The most promising about Level(s)

At the third national evaluation workshop, the test participants debated what is the most promising about Level(s). The responses suggested that Level(s) may:

- Establish a *common European vocabulary* and platform across member states, standards etc. that can help form a common framework and understanding of what sustainable construction is.
- Provide a *less demanding alternative* compared to certification schemes for documentation and reporting on sustainability where only relevant criteria adapted to the client's CSR policies or project requirements are selected and reviewed.
- Support *freedom of choice of methods* that allows "everyone" to use Level(s). It is not only large calculations or programs that are required to be used, as the freedom of choice of method opens up for using other and more simple solutions even in projects with small budgets.
- *Drive change* towards increasing sustainability in the industry both nationally and across Europe, e.g. through Level 1 as an accelerator to get more actors to gradually incorporate sustainability into their projects.
- *Influence legislation* nationally and internationally e.g. by shaping and extending requirements in national Building Regulations in a more sustainable direction for example with regard to energy frame calculations, materials etc.
- Start *establishing benchmarks* at a common and national level (some things make sense to compare nationally – others to compare internationally).
- *Improve performance and futureproofing* of projects in relation to climate change, which is a feature that has not been seen in other contexts regarding sustainability assessments and is considered as an interesting/relevant angle to include in the projects.
- Emphasise the importance of *data quality* through procedures for assessing the risk/weakness of data through self-evaluation of the level and quality of calculations as well as the person performing the test.
- Be suitable for *different levels of ambitions* and available resources.
- Initiate a dialogue or more *holistic approach* through common EU macro objectives that ensure all relevant issues of sustainability management are included, and not only those included in the national Building Regulations.
- Create an *operational framework* that can function as a checklist/to-do list and at the same time create uniformity with high degrees of freedom.
- Emphasise a more common and uniform *focus on materials* and their evaluation.

7.2 The most challenging about Level(s)

At the third national evaluation workshop, the test participants debated what is the most challenging about Level(s). The responses suggested that Level(s) is facing the following challenges:

- *Extensive improvements of the manual and assessment spreadsheet* in its present form are required as it is very difficult to understand the manual, even for highly educated

people. Not everyone will be able to keep up with it and may end up being very confused thinking that many inputs to Level(s) are done incorrectly or completely omitted due to a lack of understanding of the manual and the assessment spreadsheet.

- The *absence of benchmarks* prevents comparison of individual projects and makes interpretation of results for the individual macro objectives difficult for users not accustomed to working with sustainability.
- *Freedom of choice of the method* makes comparisons difficult and creates uncertainty as to what standards, methods, tools and input data is required.
- The system *requires extensive experience* in sustainable design from e.g. doing a DGNB certification or similar as it is technically very complex and requires knowledge and experience by the Level(s) manager of the benchmarks themselves in order to know if a solution is more or less sustainable.
- The *purpose is not expressed clearly enough* and does not hit the target group. Hence, it is difficult to see whether it is used for reporting or for assessing the level of the building in relation to others.
- The division into 3 levels does not always make sense in terms of phases and types of projects.
- Using the system on *existing building projects require improvements* with regard to the adaptation of macro objectives.
- The *value is limited* if the system is not applied from the very beginning of a project.
- The *absence of independent third party control* may compromise credibility.
- The system *cannot be used for benchmarking across Europe* due to differences in national laws, standards, methods and climatic conditions, which has an impact on the criteria to be met and may create a muddy picture of what sustainability in construction means. This in turn probably requires national adjustments of the system or a division into different zones.
- It is *very resource-demanding* especially to gather data at Level 2 and Level 3 if a DGNB certification is not already conducted, which in turn makes it difficult to persuade the developer or client to pay for the service.
- The tool is designed from an engineering and/or investor's perspective, and *architectural sustainability issues are lacking* such as daylight, planting, outdoor areas and social issues. These are soft, but very important issues for human sustainability.

7.3 Choice of level of ambition

At the third national evaluation workshop, the test participants were asked why they had chosen the level of ambition in their reporting as they did. The responses pointed at the following explanations:

- Maximise learning:
  - "As a starting point, we did not choose a specific Level. Instead, we chose to do the exercise as a test of how many indicators we could respond to with the available data on our DGNB-certified project."
  - "Level(s) 1 – Additional optional was selected to examine Level(s) and see what it required. Most of all macro objectives were filled in to get Level(s) tested and the content therein. The ambition was not to reach Level(s) 3, however, to fill more Level(s) if possible."
- Time and resources:
  - "The macro objectives were selected based on available data and time consumption. The amount of preparation/learning how to answer surprised us. We initially signed up for higher-level(s) and more macro objectives when signing up for JRC, but ended

up only doing the minimum required and only for level 1 (individual for levels 2 and 3)."
    - "Time to update data resulted in Level 1 reporting for the minimum requirement. For the final delivery, it is expected to report at several macro objectives and higher Level(s)."
- Declining ambitions during the test period:
    - "I chose all macro objectives at all levels to learn as much as possible about Level(s), but when reality kicked in I ended up with minimum level 1 requirements due to limited time."
    - Reduced number of criteria solely due to time consumption (some time went by understanding the structure and content of the individual criteria).
    - "In reality, we started out with a high aim with Level 3 as the level of ambition, but the process showed that the project could not deliver on it – but when the project was completed we really had no opportunity to make changes and optimisations."
    - "We started out being pretty ambitious but ended up at Levels 1/2 – the minimum. This is due to the large hourly consumption per macro and the lack of immediate usability of Levels. No usable measuring points."
    - "We had a higher level of ambition at the start of Level (s) than we finished with. We had the ambition to fill all indicators with different Level. We ended up filling the minimum indicators – though at different levels for the individual indicators. It was a trade-off between Level's state, time spent and the opportunity for value creation that lowered our level of ambition."
- Data availability:
    - "Project could only provide data for LEVEL 1 (in most cases)."
    - "Primarily based on possible data from DGNB certification."
    - "Level(s) level reported as high as possible with the available data. It is not a priority to obtain/prepare additional data."
    - "This was the possible level in terms of time and available data. The project is not certified, so most data had to be generated from scratch."
    - "I chose the level of ambition based on what data was available in the project. Therefore, there are answers at several different levels."
- Lack of industry experience:
    - "I made part of "Additional", but only at Level 1."
- Unclear requirements:
    - "In some cases, what was needed to achieve a higher level of ambition was opaque."

7.4 Creating value for actors and projects

At the third national evaluation workshop, the test participants were asked how Level(s) may create value for parties in the construction value chain and value for the building project.

The responses with regard to the value-added for the parties of the construction value chain included the following statements:

- Allow the consultant to offer an intermediate stage between the requirements of the Building Regulations and the requirements of a voluntary certification such as DGNB when there are ambitions for more than just the minimum requirements but not resources for a full-blown certification.
- Make sustainability measurable as a signal value without having to perform an actual certification.

- Using Level(s) as a management tool to increase focus on sustainability (and strengthening how to lead in the right direction), setting ambitions for the relevant sustainability issues and follow-up on these during project progress.
- More informed and qualified solutions through a good dialogue based on relevant data as a foundation and more calculations of solutions.
- Emphasis on decision making in the early stages of a project for making the red thread more concrete and visible throughout the project phases.
- Creating traceability for decisions through systematic documentation.
- Provide a methodology for the building owner to manage a building portfolio by mapping and benchmarking the sustainability aspects systematically.

The responses with regard to the value-added for building projects are somewhat mixed and questions whether Level(s) provide value and under what circumstances. Some respondents expressed concerns about the value as pointed in the following statements:

- “Value creation can take place if Level(s) is actively used in the design phase to evaluate solutions – similar to DGNB. If used exclusively for reporting, the value is hard to see.”
- “It is difficult to see the great value creation for the finished project that would not have been achieved with other systems. But in general, sustainability management and certifications create buildings that incorporate initiatives that might otherwise not have happened.”
- “We find it difficult to see the exact value creation for the completed construction because it depends a lot on how the sustainability manager gets the decisions implemented that Level(s) can create a reason to talk about."
- “It is possible to select the focus of a sustainability strategy (e.g. 50 % environment, 20 % economy, 30 % indoor climate) using the macro objectives of Level(s) as guidelines and test relevant indicators throughout all stages of construction. This gives the opportunity to adapt construction to the level of sustainability that is most adequate.”
- "At present, the Level(s) tool is largely a reporting of numbers without an understanding of what level or value they are generating. There is so much freedom of methodology that it appears as pure reporting without a controlled direction of where to go.”
- “Can work – when completed – as a better alternative to construction simply complying with the Building Regulations, when a builder does not want to/have finances for making a DGNB certification.”

Other respondents had a less reserved position with regard to the value and pointed at the following issues as contribution value:

- Future-proofing of buildings and lower climate footprint with lower operation and maintenance costs.
- Level(s) as a common European definition and framework for understanding how sustainability in construction is defined (what aspects are included).
- It can be a tool that can help develop a sustainability strategy.
- Level(s) create value if it is followed in the various phases and higher Levels are chosen which in some cases require variant analysis. In this way, Level(s) can help to maintain ambitions and optimise the finished project.
- Level(s) can be used directly in the upcoming voluntary sustainability class of the Building Regulations establishing baseline, prerequisites and methods.
- It can be used as a tool for a value mapping of for example a building portfolio with the aim of establishing the knowledge/baseline for one's building stock as a building owner.
- Possibility of establishing national baselines.
- Comparative studies can help find the most sustainable and hopefully viable solution.

- “Could you imagine a scheme where the industry checks each other? Certified Level(s) Advisor.”

7.5 Recommendations for improving Level(s)

At the third national evaluation workshop, the test participants were asked how Level(s) may be improved. The responses covered a wide range of issues, but the recommendations for improving Level(s) were as follows in prioritised order:

- The purpose or overall objective of Level(s) as well as the expected beneficiary needs clarification, more specifically how Level(s) is positioned along the dimensions of dialogue versus calculation and certification versus reporting.
- A general framework statement is required to explain why exactly these indicators (topics) are selected for Level(s) and others like architecture and social sustainability issues are left out.
- The manual needs to be simplified and easier to navigate both visually and linguistically as it is way too complex, too bulky, difficult to get an overview over, written in a difficult technical language, containing many overlaps and repetitions, lacks examples and graphics for easier understanding.
- The user-friendliness of the assessment tool/spreadsheet should be improved by developing a program instead of a spreadsheet, simplifying the structure, adapting it to actual workflow of projects, providing feedback through a reporting key to oversee the performance score, visualising results graphically, handling and compiling documentation better, and possibly spot-checking of documentation.
- The tools and manual needs to be more closely integrated with each other (especially Part 3).
- Benchmarks or (national) baselines are required for making comparisons between projects and assess whether one or another solution is more sustainable or not.
- The difference between the three levels (Minimum, Recommended and Additional Optional) should be clarified as they are difficult to follow when there are no points or similar. Suggestions included:
    - Adjusting Level(s) 1, 2 and 3 to the different phases as it does not make sense for all levels in all phases.
    - There is really no difference between Level 1 and 2 as to what is evaluated, but only in how to evaluate data quality. It is not something that is immediately valuable to the design or the building.
    - Reconsidering the definitions of the different levels and the intended progression of complexity as it is e.g. possible to make Level 3 without having made the others and in other cases, Level 2 means a greater degree of detail.
    - Making a Level 1 that everyone could join or consider simplifying Level 1 and saving some of the more difficult computational topics to Levels 2 and 3. This will ensure dialogue and make the tool accessible to "lay people".
    - Considering whether some macro objectives should spring from each other. For example, waste in Level 1 is perhaps too difficult, but material consumption may be the initial evaluation of future waste.
    - Clarifying the intention of the figure calculated at Level 1.
- It should be considered to establish national editions adapted to the differences in national construction projects and climate zones.
- The scope of Level(s) should be extended to a more holistic definition of sustainability that includes e.g. user satisfaction (like Post Occupancy Evaluation (POE)), social aspects, spatiality, material experience, architectural qualities, etc.

7.6 Particular challenges with regard to renovations

At the fourth national evaluation workshop, the test participants were asked what particular challenges Level(s) is facing with regard to renovation projects. The responses covered a wide range of issues summarised in the following.

7.6.1 Need for baseline registration

The first question at the fourth national evaluation workshop addressed the need for an additional baseline registration of existing conditions and operations, in particular, what conditions are needed to register and how to do so. The responses can be summarised in the following list:

- Purpose or objectives of the renovation, in particular where there are no requirements set in the Building Regulations concerning extensive renovations.
- Scope of the renovation e.g. completes renovation versus partial renovation of supporting structures or installations.
- Financial conditions.
- History of the building including the time of erection and previous renovations.
- The present and future use of the building.
- Listed or protected building including architectural value and building heritage value.
- Condition assessment of materials and constructions including estimates of an expected residual lifetime.
- Bill of quantities including the amount of recycling and replacement with new components, including recording which building parts are to be renovated in order to measure improvements due to renovation and compare with other projects.
- Environmental screening for dangerous substances like asbestos, PCB etc., which is mandatory in Danish construction but not mentioned in Level(s).
- Measurement before and after the renovation of consumption and/or operational expenses for water, energy, maintenance etc. and if possible an average over a number of years.
- Supply conditions like district heating, water supply and sewer system.
- Indoor climate conditions e.g. CO_2, VOC, humidity and temperature (variation over the year).

7.6.2 Suitability for different types of renovations

The second question at the fourth national evaluation workshop addressed the suitability of Level(s) in its present form for different types of renovations. The responses can be summarised in the following list:

- As a generic framework, it may be adapted for renovation, but the focus tends to be on major renovations as stated in the manual itself.
- The scope of the renovation has a bearing on how useful Level(s) is. It makes good sense to apply to major renovation projects where all macro objectives are in play, whereas smaller renovation projects do not necessarily include all macro objectives.
- Level(s) can be used as a dialogue tool on all types of renovation – macro objectives can be selected that are relevant to individual actions.
- Level(s) can create the basis for viewing a small renovation in a more holistic perspective instead of just solving one problem at a time with one measure.

The respondents offered some suggestions for the future development of the manual:

- Some suggested making new separate manuals for new buildings and renovation, while others objected.

- For minor renovations (replacements), a Level(s) system is needed where macro objectives can be turned on/off depending on scope.
- More focus on architecture, expression, soft values, and social sustainability.
- It may be advantageous to have a minimum requirement defined, which is not as vague as it is now. Another alternative is to make it possible to explain schematically what is being renovated and what is not.
- A simplification of the Level(s) tool/manual focusing on the steps that are needed and the specific building parts/components that can be optimised.
- Inspiration can be found in SBi Direction 296 that also addresses the topic of managing small renovation projects.
- For simple renovation tasks, some sub-goals could be compiled from the various macro objectives for new buildings into more specific objectives for renovating e.g. a window.

8

REFERENCES

8 REFERENCES

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9

APPENDIX

APPENDIX

This section includes the following appendices:

- Appendix A. Level(s) assessment reporting tool.
- Appendix B. Reliability ratings.
- Appendix C. National evaluation process.

Appendix A. Level(s) assessment reporting tool

The assessment checklist is divided into 7 steps as shown below in Figure x.

☐	**Step 1:** **Choose the indicators and tools to work with**	•**Part 2** provides a general introduction to each indicator and tool. •Check through the guidance and rules in order to inform your choice of indicators and tools. •We would recommend to brief the technical team go through the performance assessment requirements.
☐	**Step 2:** **Choose the level of performance assessment**	• Based on the goal and scope of the performance assessment, select the appropriate assessment level for the project from the three available options. • Part 1, section 3.2 provides further guidance on the difference between the three levels.
☐	**Step 3:** **Define the building to be reported on**	• Download the report spreadsheet and start by entering the description of the building and select your Level(s) reporting scope. • **Part 3, section 1.1** should be followed in order to define the building, and the associated goal and scope of the performance assessment. • If you are testing several building types you may need to create a separate spreadsheet for each.
☐	**Step 4:** **Follow the guidance and rules on how to carry out an assessment**	• **Part 2** provides a general introduction to each indicator. • **Part 3** should then be consulted for guidance on how to carry out a performance assessment. Rules are also laid down for reporting in the public domain. • The Level 1 guidance forms the common basis for all assessments, and should be consulted before using Levels 2 and 3. • Pay special attention to the reference materials, methods and standards that should be used and any specific guidance that is provided. It may be possible to use data from other assessments and sources used on the project, which could save time and resources. • The format comprises combination of data fields, background information requirements and checklists You can request help on any aspect of the Level(s) guidance and methodology by writing with precise and specific queries to the **JRC Level(s) helpdesk email**: jrc_b5_levels@ec.europa.eu
☐	**Step 5:** **Complete the reporting format**	• In each set of technical guidance in **Part 3**, a format for reporting is provided.
☐	**Step 6:** **Determine the valuation influence and reliability of the assessment**	• As an optional last step for each indicator, the potential influence on a property valuation and reliability of the data and calculation method may be rated and reported on. • **Part 3** provides a rating methodology for each indicator.
☐	**Step 7:** **Finalisation the assessment for submission**	• Once you have completed the performance assessment for a specific project stage, or compiled data for one or more completed stages, you will be ready to submit your results to the Commission. Completed spreadsheets shall be submitted to the to the **JRC Level(s) helpdesk email:** jrc_b5_levels@ec.europa.eu

FIGURE 1. Assessment checklist. Source: EU Level(s) assessment reporting tool.

The description of the building project includes information on project contact and base registration of the building along with a number of parameters, which are to be filled using the help text and/or drop-down menus. The parameters are identical for the office buildings and residential buildings, but the help text are different and two of the parameters need not be filled in as shown below in Figure x.

Parameter	Residential buildings
Location	
Climate zone	Select
Project type	Select
Year of construction	
Original year of construction	
Service life or holding period	
Building form	Select If other describe here
Property schedule	
Floor area measurement	
Market segment	Select
Servicing	
Conditions of use	
Projected occupancy density	n/a
Projected pattern of occupation	n/a
Assumed void rate	

FIGURE 2. Parameters for describing building. Source: EU Level(s) assessment reporting tool.

Input is made available by generating individual spreadsheets based on 14 indicators and tools that can be further selected according to the four different project stages in which the indicator or tool was used (Figure x).

Indicators and Tools	Project Stages				
	Design Stage	Implementation stage	Completion and handover stage	Operation and occupation stage	
Indicator 1.1 Use stage energy performance: - 1.1.1 Primary energy demand - 1.1.2 Delivered energy demand	not used	not used	not used	not used	
Indicator 1.2 Life cycle Global Warming Potential	not used	not used	not used	not used	
Tool 2.1 Life cycle tools: Building bill of materials	not used	not used	not used	not used	
Tool 2.2 - Scenario 1 Building and elemental service life planning	not used	not used	not used	not used	
Tool 2.2 - Scenario 2 Design for adaptability and refurbishment	not used	not used	not used	not used	
Tool 2.2 - Scenario 3 Design for deconstruction, reuse and recyclability	not used	not used	not used	not used	
Indicator 2.3 Construction and demolition waste	not used	not used	not used	not used	
Indicator 3.1 Total water consumption	not used	not used	not used	not used	
Indicator 4.1 Indoor air quality - 4.1.1: Good quality indoor air conditions - 4.1.2: Target air pollutants	not used	not used	not used	not used	
Indicator 4.2 Time outside of thermal comfort range	not used	not used	not used	not used	
Tool 5.1 Scenarios for projected future climatic conditions: Protection of occupier health and thermal comfort	not used	not used	not used	not used	
Indicator 6.1 Life cycle costs	not used	not used	not used	not used	
Indicator 6.2 Value creation and risk factors	not used	not used	not used	not used	Reporting sheet for indicator 6.2 will be automatically created when you generate the reporting sheet for an indicator or tool
LCA Overarching assessment tool: Cradle to cradle Life Cycle Assessment (LCA)	not used	not used	not used	not used	
Generate reporting sheets					

FIGURE 3. Generating reporting sheets for input. Source: EU Level(s) assessment reporting tool.

Indicator 1.1 Use stage energy performance may serve as an example introducing the Assessment Matrix in more detail. Indicator 1.1 Use stage energy performance focus on primary energy demand and delivered energy demand. For each of the three levels the

spreadsheet will automatically generate tabs for the user to fill in. Figure x, Figure y and Figure z illustrates the requirements for data input from the user at the three different levels.

Part 1: Type of performance assessment		
Reporting item		Reporting (select/delete as appropriate)
Energy Performance of Buildings assessment type		Calculated (asset)
Energy Performance of Buildings assessment sub-type		
Calculation method	EN standard compliant calculation method?	Yes
	Specific method used and related CEN standard series	

Unregulated (non-EPB) energy uses	
Does your national calculation method allow for a design estimate of unregulated energy uses?	No
What is the scope of the energy uses estimated?	

Part 2: Performance assessment results										
Reporting headings		Total ($kWh/m^2/yr$)	Energy uses ($kWh/m_2/yr$)							
			Heating	Cooling	Ventilation	Hot water	Lighting	Small power	Other uses	Notes
1.1.1 Use stage primary energy demand										
Total primary energy demand		0								
Non-renewable primary energy demand		0								
Renewable primary energy demand		0								
Exported energy generated		0								
1.1.2 Use stage delivered energy demand										
Heating	Natural Gas	0								

The potential for a positive influence on a market valuation

Checklist 1 – Evaluation of potentially positive influences on the market performance		
Potential influence	Evaluated?	Resulting assumptions used in the appraisal
Potential influence 1 Increased revenues due to market recognition and lower void rates.	YES	
Potential influence 2 Reduced operational, maintenance, repair and/or replacement costs.	YES	
Potential influence 3 Reduced future risk of increased overheads or loss of income.	NO	

Checklist 2 – Accounting for a Level(s) assessment in the valuation criteria used		
Valuation criteria set used		
Version of the criteria set used		
Criteria which the assessment has influenced		Influence on the valuation or rating
Valuation criterion	Sub-criterion	

Reliability rating of the performance assessment

Rating 1 - Basis for the performance assessment		
RATING ASPECT	Brief description of the aspect	Rating score
1.1 Technical representativeness of the building use patterns	Reflecting the actual conditions of use, occupancy patterns and behaviour	1
1.2 Technical representativeness of the input data used	The extent to which building materials and services input data reflect the surveyed building or as-built construction.	2
2.1 Geographical representativeness of the weather data used	The use of climate data that reflect the building location.	3
2.2 Geographical representativeness of the primary energy factors	The use of primary energy factors that reflect the building location.	3
3.1 Time representativeness of the calculation method	The extent to which simulations are a more dynamic representation of performance	3
3.2 Time representativeness of the energy demand profiling	The extent to which demand profiles support the optimisation of supply and demand.	3

Indicator 1.1 **Indicator Reliability Rating**	**2,3**

Rating 2 – Professional capabilities	
Rating aspect	Rating score
2. Technical capability of the personnel carrying out the assessment	3

Rating 3 – Independent verification	
Rating aspect	Rating score
3. Independent verification of the assessment	3

FIGURE 4. Example of assessment schema. Source: EU Level(s) assessment reporting tool.

Inputs to the simulation of a building that shall be fixed		
Use of standard input data	Data provided at national level or the default data provided in Annex G of EN ISO 13790 shall be used. This shall include the use of standard occupancy data (see Annex G.8).	
Choice of calculation method	The quasi-steady state and simplified hourly dynamic methods described in EN ISO 13790 may be used. If a dynamic method is chosen, the results shall be validated according to the criteria and test cases in EN 15265 and the variance rating reported.	
Climate data	For measured assessment, the performance shall be corrected in relation to the test reference year for the local area or region, following the method in EN 15603.	
Primary energy factor	The system boundary shall encompass the primary energy required to extract and transport the energy carried to the building, as well as any other associated operations.	

FIGURE 5. Input. Source: EU Level(s) assessment reporting tool.

Design optimisation aspects addressed		
Aspect	**Addressed? (yes/no)**	**Notes on data sources and calculation method**
Aspect 1.1 - Technical representativeness of the building use patterns		
Aspect 1.2- Technical representativeness of the input data used		
Aspect 2.1 - Geographical representativeness of the weather data used		
Aspect 2.2 -Geographical representativeness of the primary energy factors		
Aspect 3.1 - Time representativeness of the calculation method		

FIGURE 6. Design optimisation aspects addressed. Source: EU Level(s) assessment reporting tool.

Appendix B. Reliability ratings

Reliability ratings for each performance assessment in the relevant project stage needs to be carried out. The reliability ratings are divided into ratings of 3 different aspects:

- Technical reliability related to the representativeness of e.g. data input (specific for each indicator and tool).
- Professional capabilities of the team conducting the assessment.
- Independent verification of third-party.

The ratings are conducted using a four-step ladder:

- Rating aspect not adressed.
- Low.
- Medium.
- High.

The reliability ratings are summarised in individual spreadsheets for each of the four project stages (Figure x):

Reliability ratings for each performance assessment			
Indicator or scenario	**1. Technical reliability rating**	**2. Professional capabilities rating**	**3. Independent verification rating**
Indicator 1.1 Use stage energy performance: - 1.1.1 Primary energy demand - 1.1.2 Delivered energy demand	0,0	0,0	0,0
Indicator 1.2 Life cycle Global Warming Potential	0,0	0,0	0,0
Tool 2.1 Life cycle tools: Building bill of materials			
Tool 2.2 - Scenario 1 Building and elemental service life planning			
Tool 2.2 - Scenario 2 Design for adaptability and refurbishment	0,0	0,0	0,0
Tool 2.2 - Scenario 3 Design for deconstruction, reuse and recyclability	0,0	0,0	0,0
Indicator 2.3.1 - IRI estimates and potential Construction and demolition waste	0,0	0,0	0,0
Indicator 2.3.2 - IRI on site accounting Construction and demolition waste	0,0	0,0	0,0
Indicator 3.1 Total water consumption	0,0	0,0	0,0
Indicator 4.1 Indoor air quality - 4.1.1: Good quality indoor air conditions	0,0	0,0	0,0
- 4.1.2: Target air pollutants	0,0	0,0	0,0
Indicator 4.2 Time outside of thermal comfort range	**0,0**	**0,0**	**0,0**
Tool 5.1 Scenarios for projected future climatic conditions: Protection of occupier health and thermal comfort	**0,0**	**0,0**	**0,0**
Indicator 6.1 Life cycle costs	**0,0**	**0,0**	**0,0**
LCA Overarching assessment tool: Cradle to cradle Life Cycle Assessment (LCA)	**0,0**	**0,0**	**0,0**

FIGURE 7. Reliability ratings for each performance assessment. Source: EU Level(s) assessment reporting tool.

Appendix C. National evaluation process

Workshop 1: Kick-off

Date: 9 January 2019 at 13-16

Place: C. F. Møller, Danneskiold Samsøes Allé 28, 1434 København K

Purpose: The kick-off workshop introduced Level(s); provided an overview of the purpose, expectations and process of the national test; gave examples of how the test could be carried out for two of the macro objectives; and assigned tasks to the 6 different workgroups.

Agenda:

- 13.00 Introduction: Purpose of the test, expectations and course – Peter Andreas Sattrup & Majbritt Juul
- 13.30 Introduction to Level (s) Macro Objects and Indicators – SBi
- 13.45 Example: LCA and macro objectives MO1 & MO2 – Henriette Falk Olesen, Årstiderne Arkitekter
- 14.00 Example: LCC and macro objective MO 6.1 – Jesper Ring, Dominia / Frame
- 14.15 Break
- 14.30 Task for workshop 2 – Peter Andreas Sattrup
- 14.40 Platform for communication between project participants – Henriette Falk Olesen
- 14.45 Group discussion – how do we solve the task?
- 15.45 Summing up and program for Workshop 2 – Peter Andreas Sattrup
- 16.00 Adjourn

Workshop 2: How to report macro objectives 1-6

Date: 31 January 2019 at 13-16

Place: Dominia, Ved Vesterport 6, 3.sal, 1612 København V

Purpose: The second workshop aimed at discussing preliminary experience with reporting on the different tools and indicators of the 6 macro objectives.

Agenda:

- 13.00 Introduction: Progress, expectations and process – Peter Andreas Sattrup
- 13.15 Presentations from the groups: Experiences and advices for reporting with macro objective 1-6. Each group had a total of 15 minutes to present its macro objective and its indicators as well as subsequent discussion of plenary challenges.
- Using the test indicators and life cycle tools
    - 1.1 Use stage energy performance
    - 2.1 Life cycle tool: Building Bill of Materials (BoM)
    - 2.2a Scenario 1. Building and elemental service life planning
    - 2.2b Scenario 2. Design for adaptability and refurbishment
    - 2.2c Scenario 3. Design for deconstruction, giant and recycling
    - 2.3 Construction and demolition waste and materials. A cradle to cradle Life Cycle Assessment (LCA) of a building
    - 3.1 Use stage water consumption
    - 4.1 Indoor air quality (design indoor conditions and target pollutants)
    - 4.2 Time out of thermal comfort range
    - 5.1 Protection of occupier health and thermal comfort
    - 6.1 Life Cycle Cost (LCC)
    - 6.2 Value creation and risk factors
- 14.45 Pause
- 15.00 Next step: The task of Workshop 3: The companies' reporting and evaluation
- 15.05 The framework for SBi's evaluation – process and outcome
- 15.20 Discussion in groups: How do we organize the work towards Workshop 3?

- 15.35 This is how we plan to solve the problem: Henriette Falk Olesen and Jesper Ring
- 15.50 Summing up and questions
- 16.00 Adjourn

Workshop 3: Lessons learned and reflections

Date: 2 May 2019 at 13-16

Place: SWECO/Aarstiderne Arkitekter, Ørestads Boulevard 41, 2300 København S

Purpose: The third workshop aimed at sharing lessons learned from testing Level(s) and reflecting on the need for further development of Level(s) seen from a Danish perspective.

Agenda:

- 13.00 Introduction – Peter Andreas Sattrup
- 13.15 Preliminary lessons learned – Kim Haugbølle & Harpa Birgisdottir
- 13.30 Discussion round 1 on evaluation – Kim Haugbølle & Jesper Ring
- 14.30 Break
- 14.45 Discussion round 2 on future perspectives – Kim Haugbølle & Jesper Ring
- 15.45 Summing up – Peter Andreas Sattrup
- 16.00 Adjourn

Workshop 4: Challenges related to renovation projects

Date: 24 June 2019

Place: Rambøll, Hannemanns Allé 55, 2300 København S

Purpose: The fourth and final workshop aimed at discussing challenges related to renovation projects in particular.

Agenda:

- 10.30 Introduction – Peter Andreas Sattrup
- 10.45 Summing up from previous workshop – Jesper Ring
- 11.00 Group work 1: Discussion of 1) need for baseline registration and 2) scoping of renovation tasks – Jesper Ring & Harpa Birgisdottir
- 12.30 Lunch
- 12.30 Group work 2: Discussion of 3) points to pay particular attention to with regard to the 6 macro objectives and 4) which macro objectives is missing in Level(s)? – Jesper Ring & Harpa Birgisdottir
- 13.45 Summary – Peter Andreas Sattrup
- 14.00 Adjourn

This report covers the evaluation of the Danish test of the proposal for a new joint European reporting scheme for sustainable construction named Level(s). The Danish evaluation included a total of 18 building and renovation projects involving a large number of Danish companies. The evaluation focuses on three key aspects of the testing of Level(s): 1) How useful was Level(s) in assessing the sustainability of the buildings? 2) How did the design of Level(s) support the process of assessment? 3) How user-friendly were the indicators and life-cycle tools chosen together with their associated guides?

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